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JANUARY

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CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

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Dr. Erickson has recently returned to his post as professor of geography at the University of North Carolina after prolonged leave of absence in Washington, whither he went for service with the Office of Strategic Services where he was engaged in cartographic research.

Lieut. Lynch, U.S.N.R., professor and Head of the Department of Geography at Oklahoma A. and M. College, Stillwater, is now on leave of absence from the college. He has been on foreign service.

Dr. Picklesimer, Head of Department of Geography at East Carolina Teachers College, Greenville, North Carolina, has done considerable research on the tobacco industry.

Ensign Galvin, U.S.N.R., received his A.B. degree from the University of Washington in 1943. He is now on active duty in the Pacific.

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TUNG OIL

UNTIL relatively recently, China has been the major source of tung oil. There the trees that produce it are widely distributed throughout the land. They have for centuries yielded a product that has contributed substantially to China's economy and cultural progress. For decades past increasing quantities have been exported, and tung oil has become recognized the world over as a valuable addition to the materials serviceable to the arts and crafts.

Not many years since, tung tree culture was introduced into the United States, and flourishing plantations have been established in a number of our southern states where conditions of climate, soil, and drainage are suitable for the growth of the tree. Thousands of acres have been planted, and though many areas have already failed in successful production, other sections have been highly fortunate, and bid fair to compete so favorably with Chinese areas of production as to decrease significantly, if not to eliminate, the importation of Chinese oil.

It may be that synthetic resinous varnishes may be compounded and produced industrially in the near future, entirely to replace tung, just as synthetic indigo completely terminated the growing of indigo in America where it had been introduced, and in its native lands, particularly India; and just as synthetic rubber from various sources is displacing plantation rubber from Malaya and other regions, and wild rubber from the Amazon Basin. Organic chemistry is well on its way toward reproducing synthetically many such commercial raw materials, previously obtained solely from natural sources.

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MEETING AN EMERGENCY IN TRADE

Wallace W. Atwood

ALL the world, except Japan, is gasping for rubber. In many lands there is a shortage of tin, tungsten, quinine, vegetable oils, and Manila hemp. We, in the United States, need 600,000 tons of rubber this year. We formerly obtained virtually all of our supplies of rubber, much of our tin, quinine, tungsten, vegetable oils, and all of our Manila hemp from the southeastern part of Asia and the neighboring islands. As the Japanese forces swept southward our supplies of these very essential products were suddenly cut off. Never before have we in the Western Hemisphere been faced with such a catastrophe. Our supply lines were cut just at the time when the United States, because of a gigantic expansion of war industries, had its greatest need for raw materials.

In prewar days Bolivia produced about one-sixth of the world's supply of tin ore each year. After the sources of that very important metal in Malaya, the Netherland Indies, China, and Thailand were cut off by the Japanese, we turned to one of our South American neighbors for all the tin she could produce.

The Bolivian ore had formerly been taken to England to be smelted but the United States government promptly arranged for the construction and equipment of a smelter for treating these ores in Texas. Bolivia has no smelters.

The ores from Bolivia leave that inland country, high among the Andes, by a railroad about 300 miles in length from La Paz through northern Chile to the port of Arica. There they must be transferred to vessels and taken northward, through the Panama Canal and to the coast of Texas or other American ports. Tin ore constitutes 75 per cent of the exports of Bolivia. Tungsten, antimony, copper, silver, lead, zinc, and bismuth are other important mining products from that country.

The United States has entered into a contract to buy 18,000 tons of tin annually for five years from Bolivia. We have also contracted to purchase 3,000 tons of tungsten each year and have loaned to Bolivia $25,000,000 "for the construction of four major highways, the establishment of a national sugar industry, the stimulation of petroleum production, and other economic purposes."

We have turned, naturally, to the tropical sections of the western world for certain strategic products that formerly came from the warm lands of the Southwest Pacific. In 1912 10,000 tons of natural tree rubber came to the United States from the Amazon countries. At that time the natives of that

lowland region were in the habit of tapping the wild rubber trees in the dense, tropical forest of Brazil. They brought out the milky white latex and on the banks of the Amazon, over smouldering fires, prepared this valuable raw material, used in the manufacture of a thousand useful articles, for shipment. That region has produced up to 50,000 tons of crude rubber in a year. Why should it not supply still more? It is the homeland of the Hevea tree, which yields the best rubber latex, and, if plantations can be established and sufficient laborers obtained, there is no reason why Brazil cannot replace the Malayan Peninsula and the East Indies as the chief sources of crude rubber.

In 1876 Henry A. Wickham smuggled out of the Amazon lowland at least 70,000 seeds of the rubber-producing tree. He took the seeds to England where they were carefully planted in nursery beds. From those 70,000 seeds, little trees were started that were taken to the Malayan lands and in time to the Netherland Indies. They are the ancestors of nearly all of the 8,000,000 acres of rubber trees in the East Indies and Malaya of today.

Since the Pearl Harbor incident of December 7, 1941, at least 15,000,000 rubber trees have been planted in Latin America. More than 100,000 workers and their families are moving into the Amazon country from Brazil, Bolivia, Peru, Ecuador, Venezuela, and Colombia. They are moving there to be the gatherers of rubber. At first they will work on the 300,000,000 wild rubber trees scattered through the broad expanse of the Amazon lowland. The wild trees must be located, trails must be cut through a dense rain forest, each tree must be tapped and visited daily. It is expected that the wild rubber trees will produce at least 70,000 tons of rubber in 1944.

A fund of $5,000,000 has been made available by the United States Government to help in promoting this project and expanding the production of the latex. Rubber tree seeds and seedlings have been brought to the Amazon lowland in Army bombing planes. One hundred coöperative nurseries have been established in fifteen countries of Latin America. Just before the Japanese invasion into the far eastern rubber-producing lands, millions of seeds and seedlings were taken from that part of the world and brought to the Americas. Twenty-five million seeds have now been distributed to twelve of the tropical countries in the Americas.

All this is but a beginning, for we need huge quantities of rubber. Each airplane tire requires 30 to 100 pounds of rubber. The tires used on supply trucks have from 100 to 500 pounds of rubber. A medium sized tank requires a tire in which there are 1700 pounds of rubber. A battleship uses 7,500 tons or the equivalent of the rubber in 17,000 automobile tires.

The lowlands of Brazil have suddenly become the scene of great activity. That region is now teaming with life and humming with activity. The old town of Manaos, a thousand miles up the Amazon, has again become the principal center of the rubber industry in the western world. The town is 273 years old and in the earlier period of rubber production it was picked out for the development of a great metropolis, the capital of the rubber world. A $10,000,000 opera house, "Theatre Amazonas," which has been almost deserted for years, may become more than a relic and a shattered dream.

To care for the new influx of settlers into the Amazon lowland a chain of medical centers has been projected.

Doctors and medical supplies are being brought in by air transport. Fifty infirmaries have been planned. Modern science is being called upon to care for these rubber gatherers and their families.

Numerous inter-American development commissions have been established. There is one in each of the American republics. These organizations aim to expand industry, improve the financial relationships within their own countries and between their home countries and the United States. Agricultural and mining conditions will be improved; also transportation facilities. The channels of trade and business will be expanded as well as the production of many articles formerly obtained from the southwest Pacific.

Since the World War opened for the United States, we have seen a rapid expansion of air transport in the Americas. We have also seen the elimination of axis interests in the air lines and in the other industries in Latin America. The Pan-American Highway System has been extended. The Canadian-Alaskan Highway has been completed. A huge steel mill is under construction in Brazil and plans are being developed to utilize much of the high-grade iron ore that has long been known to exist in the highlands of that country. Other plans for the expansion of manufacturing in Brazil are under way. In Mexico there has been a rapid development of industries. A determined effort is being made in Chile to expand and diversify industries. Many consumer-goods factories have been established in Latin American countries.

In several of the tropical and subtropical lands, not included in the Amazon lowland, plantations of rubber trees have been established. In Mexico two of the old rubber plantations have been put to work again and five new demonstration plantations of the Hevea tree have been established. Hevea matures in from 8 to 10 years and then produces 800 to 1200 pounds of latex annually per acre. Smaller quantities are obtained from the trees after five or six years. Honduras has now a 500-acre nursery of rubber trees and Guatemala has 25 nurseries for the development of trees. Costa Rica and Panama are coöperating in this enterprise. Ecuador, Colombia, and Peru have other nurseries and are looking forward to the establishment of rubber-tree plantations.

One of the most serious losses to the United States, that came with the Japanese advance, was due to the cutting off of our supply of Manila hemp from the Philippines. The fiber, which comes from the abacá plant, is the best fiber that has been discovered, anywhere in the world, for the production of rope and twine. Abacá has the qualities needed on vessels where the ropes are exposed to frequent wetting with salt water. The best substitutes for Manila hemp are henequen and sisal which have been produced in large quantities on the Yucatan peninsula of Mexico and on certain of the Caribbean islands. In Central America several of the countries are now experimenting with the growing of abacá. New henequen plantations have been established on the Dominican Republic.

Among the drugs which we have commonly imported from the southwest Pacific is quinine, obtained from the bark of the cinchona tree. Shortly before the Japanese gained control of the Philippines, officers of the Forestry Service left in a "Flying Fortress," taking with them 2,000,000 seeds of the cinchona tree. Those seeds were placed in hothouses in the United States and suitable lands have been located where those trees will grow. They

should be placed in areas 4,000 to 6,000 feet above sea level where there is a dry season lasting not more than a month and a half. Parts of Costa Rica and Guatemala seem to be suitable for these trees. Costa Rica now has 10,000 acres planted with the cinchona tree, and in Guatemala there are large cinchona plantations. In Bolivia cinchona trees grow at an elevation of about 10,000 feet above sea level. Such trees will undoubtedly be planted in parts of Brazil and Mexico.

For many years we have imported on a large scale from Japan a powerful insecticide, Pyrethrum. This drug is extracted from a daisy-like flower which is known to grow in Brazil, Chile, Peru, and the Argentine. We will now look to those southern countries for a supply of the drug. Ecuador is experimenting with the cultivation of barbasco. The root of that tree is a source of another powerful insecticide called rotenone. In 1940 we imported into the United States 6,000,000 pounds of this material.

For some years experiments have been carried on in El Salvador in the cultivation of roselle. The seed of this plant was brought from Java. When the plant is well grown it becomes a source of a fiber which may serve as a substitute for jute, a substance for which the entire world has looked to India.

Among the forest products in tropical America, that are coming into greater use, mahogany is conspicuous. More of that wood is needed for veneer and in the manufacture of plywood boards. Such boards are used in the manufacture of many parts of the P. T. boats and in the construction of our large transport planes and bombers. Central America, Cuba and Haiti, and other nearby lands have long been our chief source for mahogany.

Balsa, which is the lighest wood known in the world, twice as light as cork and much stronger, is now needed in larger quantities than ever before. This wood is used in the construction of the "mosquito bombers," in making life-preservers and mine buoys. For many years Ecuador has produced about 98 per cent of the world's total output of balsa. Today Ecuador is our chief source of balsa wood but the tree is found in other American countries, notably Costa Rica. Thus, the tropical and subtropical lands of the Americas are coming to the rescue of the people and industries deprived of imports from the southwest Pacific area.

THE COTTON BELT OF NORTH CAROLINA

Franklin C. Erickson

FROM earliest times cotton has been one of the principle agricultural crops of North Carolina. The acreage of farmland devoted to cotton increased steadily from 390,000 in 1866 to a peak of 1,817,000 in 1926.

Since 1926 a decrease in cotton acreage has taken place at an exceedingly rapid rate, with over a million acres being taken out of cotton production in thirteen years.

Because of more favorable conditions for competing cash crops, especially tobacco, this reduction in cotton acreage has been more drastic in the eastern part of the state than in the south western Piedmont.

Cotton requires about 200 frostless days during the growing season, a good summer rainfall without too great an excess of rain, a uniformly warm summer without too excessive heat and bright sunshine. These climatic conditions prevail over a large part of the state except in the north central section and the western mountain region.

The great variety of soils developed within North Carolina lend themselves to the production of cotton, provided the soils are well drained. Seventy-five of the one hundred counties in the state grow some cotton, giving the general impression of widespread suitability of physical conditions for the growth of this crop. Actually, only one fifth of the state's crop land or about four per cent of its total land area is devoted to the production of cotton.

The Cotton Belt, the area within which more than ninety per cent of the state's cotton is grown, can be divided into two sections, the western and eastern areas. The limits of the western region are determined to a great degree by physical conditions, while the eastern section is largely determined by both physical and economic conditions.

Mountains and hills form the limit of the Cotton Belt in Polk, Rutherford, Cleveland, and Catawba Counties. Eastward, soil and economic conditions form the boundary of this agricultural crop. Throughout Iredell, Davie, Rowan, and Cabarrus Counties, red clay loams derived from fine-textured granites are a little heavy for good cotton production. The same is true in Stanly, Montgomery, and Richmond Counties, where fine-textured soils have been derived from slates. The porous Sand Hill Belt in Montgomery and Richmond Counties is practically devoid of cotton production and divides the state's Cotton Belt into two separate regions.

From this line southward to the South Carolina State line lies the south western Piedmont cotton area.

The eastern region of the Cotton Belt is confined chiefly to the western half of the Coastal Plain and parts of the eastern Piedmont. The western limit of this region coincides with the Sand Hill Belt found in parts of Scotland, Hoke, Cumberland, and Harnett Counties, while the eastern boundary is limited by swamp and poorly drained soils in eastern Robeson, southern Sampson, and Duplin Counties.

North of Harnett and Duplin Counties, physical conditions exert less influence in limiting the Cotton Belt, for soil and climatic conditions are generally favorable to cotton produc-

tion. It is in this northern part that economic factors assume the leading role in the establishment of the Cotton Belt, for cotton enters into direct competition with tobacco, peanuts, and truck crops as a cash crop.

The western region of the Cotton Belt consists of several types of soils, but red soils dominate. Most of Polk, Rutherford, Cleveland, Catawba, Lincoln, Gaston, Iredell, Rowan, Cabarrus, and Mecklenburg Counties have extensive areas of red clay loams and sandy loams of the Cecil series derived from fine-textured granites. These soils are characterized by their red clay subsoils, while the surface soils range in color from gray to red. The lighter colors are usually restricted to the sandy members, with the red colors associated with the heavier types.

In Stanly, Union, Montgomery, and Anson Counties, slate soils prevail with Georgeville and Alamance series dominating. The Georgeville series is characterized by red to gray surface soils with red silty clay subsoils, while the Alamance series has light-gray surface soils and yellow subsoils.

Both series are predominantly silty in texture. Most of the cotton of the western region is grown on the lighter soils, because of better drainage. However, much cotton is grown on soils which are not so well suited to its production, because of the need of a cash crop. A cash crop has been, and is still, necessary in this part of the state, and cotton, at present, appears to meet the need better than any other crop. If there were sandy loams within the "Slate Belt," it is probable that no cotton would be planted on Georgeville soils.

While there has been a general decrease in cotton acreage over the state since 1926, the average decrease in the counties of the western region was less than the decrease in the counties of the eastern region during the period 1929–1940. There is a greater percentage of larger farms devoted to cotton production in the western region than in the eastern region. Both of these conditions can be ascribed to the lack of competition from other cash crops.

It is not to be assumed that one sees cotton field after cotton field for miles on end in this part of the Cotton Belt, for such is not the case. Large areas of wooded tracks, cut-over forests, much pasture and fallow land occupy most of the region. The land area devoted to crops in the counties composing this section varies widely, from twenty per

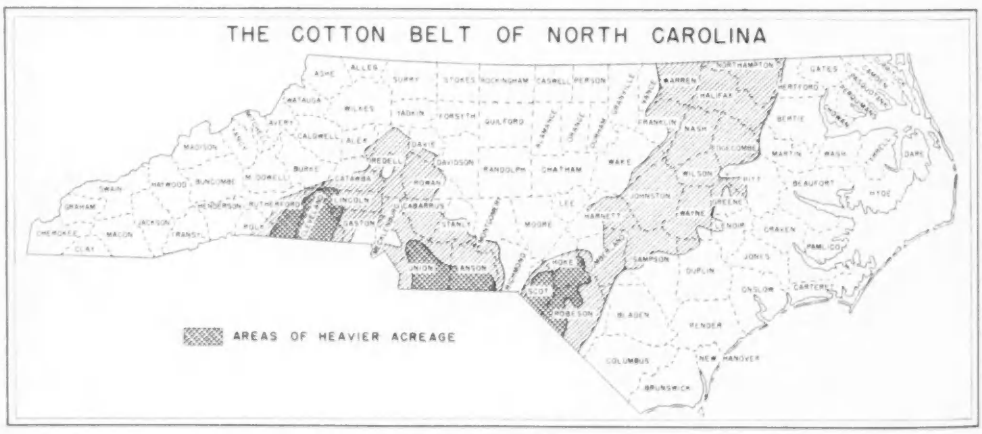

FIGURE 1—The Cotton Belt of North Carolina

cent to fifty per cent. Only in such counties as Cleveland and Rutherford does cotton occupy slightly more than ten per cent of the land. In most of the other counties it occupies between five and ten per cent of the land area.

Corn, wheat, small grains, hay, and dairying take their place beside cotton.

Within this region there are two areas of low cotton acreage; one in central Iredell County, the other including southeastern Gaston and southwestern Mecklenburg Counties. The low cotton acreage in both of these areas can be ascribed chiefly to the urbanization and industrialization of these regions and to poor soils. In the latter area lies Charlotte, the largest city in North Carolina, Gastonia, and Lowell, as well as many other towns and villages with textile mills, furniture factories, and miscellaneous industries employing thousands of workers.

Also in this part of the Cotton Belt there are two large areas of heavy cotton acreage. The great concentration of cotton textile mills in this part of North Carolina and adjoining South Carolina creates a demand for this raw material.

The Sand Hill soils are exceptionally well drained, both in the surface soil and subsoil. These soils contain only a small quantity of plant food material, because the parent material is low in mineral elements essential to plant growth and because most of the soluble plant food material and organic matter has been leached out. Only a small acreage scattered throughout this zone is devoted to cotton, separating the Cotton Belt into a western and an eastern region.

Practically all of the eastern region of the Cotton Belt lies within the inner half of the Coastal Plain. Like the western region, it also consists of several types of soils, but gray and light-colored soils predominate. Most of the soils in this area are Norfolk and associated soils. The parent materials forming these soils were brought down by streams from the Piedmont Plateau and deposited in the sea when this portion of North Carolina was covered by the Atlantic Ocean.

The Norfolk soils consist of a yellowish-gray, light-gray, to white surface soil and yellow, friable sandy clay or sand subsoils. They are usually well drained and well suited for the production of cotton. This section of the state was once the leading producer of cotton, and cotton was the leading cash crop. Such is not the case at the present time.

Norfolk soils are well suited for tobacco, peanuts, truck crops, and fruits, thus, cotton enters into direct competition with these cash crops. As a result, the counties in this eastern region have shown a greater decrease in cotton acreage during the period 1929–1940 than the counties of the western region. In general, less area is devoted to crop lands in the eastern region than in the western region, and the cotton farms are smaller in size.

In most of these counties cotton occupies a small per cent of the land area, although the percentage of cotton to crop land may be as high as twenty. Over most of this area tobacco holds the spotlight among the cash crops and has preference over cotton in the choice of soils. Farmers throughout this region, who have a choice of several cash crops, prefer to devote some land to each of these crops rather than to specialize in any one crop. Such a policy tends to favor the farmers of the eastern region in many ways. It serves as insurance against the failure of any one crop as well as against low prices for some crops. Further, labor costs can be spread over the year because

of the dovetailing in the peak labor load for these crops.

The peak labor load in the production of tobacco occurs during July, August, and September, during the picking and curing season. September is the month for peanut harvest, and in October the peak labor load in cotton picking is reached.

Actually, there has been little change in the pattern of the Cotton Belt in its broad aspects during the past few decades. While there have been acreage changes within the belt, the borders are based largely on physical conditions, and thus the limits of the Cotton Belt cannot be expected to be changed radically. North Carolina will continue to be an important producer of cotton for years to come, provided cotton brings a satisfactory financial return to the farmer.

CZECH FARMERS IN OKLAHOMA

Russell W. Lynch, U.S.N.R.

THE ethnic farm groups or agricultural culture islands which are found scattered throughout the United States present a fruitful field for study which has by no means been neglected by students over a considerable period of years.

In these times when we are so seriously concerned over the future of agriculture in this country studies of the more successful of these settlements have a special value, particularly when their setting is an area where the native American approach to agriculture has been less successful.

In Lincoln County, Oklahoma, there is a Czech culture island in the vicinity of the town of Prague which the author made the subject of a study during a three-year period from 1938 to 1941.

The county has run through the familiar cotton belt cycle from virgin land to land abandonment, poverty, and high tenancy in the short span of a half century. The Czech group, on the contrary, has shown a much higher degree of stability than the native American population, although the principal cash crop of the group, like their neighbors, is cotton.

The object of the study was to apply some measures to indicate the degree of difference in stability existing between the groups after a half century in the county and to discover to what these differences could be attributed. For this purpose, in addition to the Czech group to be considered three native American control groups were selected for the county, on a township basis. Two of these groups were entirely out of contact with the Czech group while the third consisted of the remaining farmers in the two townships in which the Czech group was located.

For all groups climate, soils, vegetation, and topography were approximately the same. The period of settlement was the same for all, as all groups lay in the eastern half of the county on the land of the Sac and Fox Indian Reservation, settled by a "run" on a single day in 1891.

Three major aspects of group stability were examined as quantitatively as possible: group mobility and tendency toward movement; group relationships with the land; and group social existence.

Some Aspects of Group Mobility and Tendency toward Movement

Mobility has been characteristic of the agricultural population of Lincoln County, with the preponderance of movement away from the land. This characteristic was reflected in the control groups which lost 16.5, 22.6, and 23.1 per cent of their population respectively between 1930 and 1940. In the same severe period of agricultural stress the Czech group lost only 1.2 per cent.

Even among the less fortunate of the Czech tenants this record was accomplished with very little government aid. W.P.A. records showed only 3.7 per cent of the Czech group certified for W.P.A. employment as against 26.6 per cent of the farmers in the control group occupying the same area as the Czechs.

The amount of tenancy, another factor which influences group mobility, was less among the Czechs than the control

groups. Control groups had 78, 66, and 61 per cent respectively, while the percentage for the county was 61.3 per cent. Tenancy among the Czechs was 44 per cent.

Kinship tenancy, less favorable to mobility was high among the Czechs and low in the control groups. Both owners and tenants among the Czechs had been on their farms longer than control group farmers.

Thus from the point of view of actual movement or of conditions which would indicate a tendency toward movement under conditions of economic stress the Czechs were outstanding in the county.

SOME ASPECTS OF GROUP RELATIONSHIPS WITH THE LAND

An analysis of 487 A.A.A. farm schedules for 1938, of which 82 were Czech revealed both marked similarities and marked differences in the agriculture of the Czechs and native American groups.

The two most important similarities were in the size of farm operated and the general combination of crops. All groups operated farms which were mostly between 80 acres and 160 acres in size, with 160 acres the model size. This fact was important because it indicated that differences in farming success were not due to differences in farm size.

Neither did farming differ in the major crop choices. By groups, cotton was the common cash crop and oats, corn, and grain sorghums the common grain crops.

The differences in agriculture were more numerous. The Czechs cultivated more land per farm than the control group farmers. They had part of the additional acreage in cotton production, so that the average cash income per farm was higher, and the balance in feed for their animals. More Czechs than native Americans kept animals, and the Czech group averaged more workstock, cows, hogs, and chickens per farm than the native American groups.

Czech farmers favored oats, wheat, and barley more, and clean-tilled corn and grain sorghums less than did the native American groups. They practiced more crop rotation and used more complex rotations.

Gardens and orchards were commoner on Czech farms and the preparation of food on farms for home consumption was more universal.

A field survey showed that in both the farm plant and the equipment for comfortable farm living the Czechs were a superior group.

The Czechs had a little more machinery per farm, on the average than native American farmers. They also had more outbuildings and barns to house machinery and stock, and kept them in better condition.

In both material and cultural conditions Czech homes averaged better than the control groups. The homes themselves were in better physical condition than the native American homes. Czech farm yards were more frequently landscaped, or at least kept in a neat clean condition. More Czechs had windmills and water piped into the house while radios, telephones, and automobiles were commoner among them than the native American control groups. Over the half century the Czechs had built up more complete and better equipped farm plants than their native American neighbors.

As for the condition of the soil on farms, the limited statistical evidence available showed the Czech farm land to be in better condition. Aerial photographs made for the A.A.A. in 1938 showed gullying to be common to the farms of all groups. No differentiation between groups was possible in this

respect. Terracing had been practiced by all groups, but more generally by the Czechs and the native American control group in contact with them than by the groups in the other two areas.

Field surveys however indicated that the Czchs did somewhat more fertilizing, as a group, while they also rotated crops more generally and used more complex rotation systems.

That the somewhat better care of the land resulted in better soil conditions was born out by higher average per acre cotton yields assigned Czech farms as compared with control group farms by local A.A.A. committees for 1939. The differences were sufficient to be significant, and are regarded as important evidence because the allotments were made by experienced local farmers.

SOME BASIC CAUSES FOR AGRICULTURAL DIFFERENCES

Undoubtedly a great deal of the difference in conditions on Czech and native American farms, considered by groups, arises from a difference in cultural background. On the one hand the frontiersman "skin the land and move on" attitude of the native American groups sent Lincoln County through the cycle from virgin land to land abandonment, high tenancy, and ruin with amazing speed. In half a century they have failed either to maintain the productivity of the land or to build up their farm plants. From an early condition in which the county was the leading cotton producer in Oklahoma agriculture moved to a state in 1940 where grain sorghums—a poorland crop—occupied more acreage than cotton. Ten per cent of the total area of the county had been abandoned due to erosion; only four per cent of the cultivated land—mostly bottom land—was uneroded. Tenancy in the county climbed from zero at settlement to 61.3 per cent in 1940, at which time flight from the land was in full progress as evidenced by a large decline in farm population between 1930 and 1940.

All current figures indicate the inadequacy of the native American approach to the problems of agriculture in the county.

On the other hand the Czech group had been conditioned by centuries of land scarcity. In Europe they were accustomed to self-sufficiency and land preservation as a matter of necessity, and these attitudes carried over when they came to this country and have been passed on to their children. It is a matter of pride with the Czech farmers that their fields are well kept and their larders well stocked. These attitudes are reported by others as typical of Czech farmers throughout the country.

Conditions associated with emigration probably brought to this country somewhat better than the average Czech farmer in energy and ambition, both of which found little scope in overcrowded Bohemia and Moravia and this, as well as their cultural approach is reflected in their position in Lincoln County.

Likewise, settlement of the land by the "run" method did not bring to the county the best of American agriculturalists. Thus adjustments in the make-up of the population have been more serious among the native Americans than among the Czechs. Yet differences in the approach to agriculture, to farm living, and to group social relationships and farm-village ties clearly indicate the importance of the cultural element in the results attained.

SOME ASPECTS OF GROUP SOCIAL RELATIONSHIPS

Any analysis of group stability and its causes would be incomplete without a consideration of the social organization of the Czech group and the farm-village ties they have formed with the village of Prague. The more adeqate and complete are social organizations and farm-village ties, the more stable the farm group is likely to be, regardless of the purely economic aspects of its agriculture.

Most of the native American control group members belong to no social organization at all, not even a church. Organized social existence in which the farmers of any of the native American groups could acquire any feeling of unity or social responsibility to the community were simply lacking. Their village ties are few and sketchy. Theirs is the frontier heritage of the isolated farm and farm living.

On the other hand the Czechs were but one step removed from the nucleated farm-village type of existence in Europe in which coöperation in social affairs and village organization were a part of daily life. Where the Czech farmers found lacks of this sort in this country they provided their own means for overcoming them.

In the Prague area the Czechs were a close-knit group in their social relationships, bound together by certain distinctly Czech organizations, but also participating more than generously in the social organizations and activities of the community at large.

The most important Czech social agency in the area was a Czech lodge in Prague, of which most of the group were members. While primarily a ritualistic lodge with insurance features, the large lodge hall served as the center for all sorts of activities in which young and old participated in social, educational, and cultural events of a wide variety of sorts. Through these close contacts group ideals, group loyalties, and group stability were fostered in a way for which there was no equivalent among the native American groups.

Other Czech organizations were a Catholic church and lodge, and a Sokol lodge, the latter a youth training organization, much less active than in former years. Only a small percentage of the community was Catholic; most Czech social activity centered around the Czech lodge rather than around the church.

The relationships of the Czechs with the village of Prague were varied. Czechs participated actively in educational affairs, politics, and community affairs of a wide variety of types.

On the financial side, they invested substantially in village real estate, and constituted a substantial percentage of the depositors to the two flourishing banks the village of Prague supports.

The Czechs—numbers of them formerly farmers or sons of farmers—also constituted a growing percentage of the businessmen of the town out of proportion to the percentage of the town population they represent. Farmers who quit farming look to Prague as a place for jobs, a new profession, or retirement, with reasonable prospects. For example of 63 Czechs who had farm sales between 1924 and 1939, 16 per cent took jobs in Prague, 8 per cent opened businesses in Prague, 14 per cent retired to live in Prague. Thirty-two per cent continued farming within the community. Thus in very hard times 70 per cent of those having farm sales were retained as a part of the Czech community, more than half of these through the nature of their farm-village relationships.

In social organization, particularly

their own group organization, seems to lie the very core of Czech stability. Their broad social existence and their close strong ties with their village center undoubtedly have a great deal to do—in both material and non-material ways—with the continued stability of the Czech group.

SOME CONCLUSIONS

Basically what are the causes for the superior stability of the Czech farmers of Lincoln County over the native American farm group? Largely the attitudes, ideas, and techniques which they have brought to bear on the problems of agricultural existence.

The Czechs have worked out for themselves a better, fuller social existence, through which group spirit and group tenets have been maintained. They have allied themselves more closely with their village center both economically and socially, to the mutual benefit of both. They have assumed and maintained a group of attitudes toward the land which are invaluable in promoting sound farm operation and pleasant farm living. Briefly summarized, these include respect for the land they farm and the use of whatever means become available to maintain its productivity. In the old world land was scarce; one could not exhaust a farm and move on. Also, the Czechs respect the land as a means of investment and return a portion of their income to both the land and the farm plant. The Czechs believe in self-sufficiency as an essential part of farm living, not at the expense of the commercial crop, but through adding time, effort, and planning to that devoted to cotton. The Czechs respect the land as a place to live. They see it as a place of permanent abode and set up social institutions and comfortable home surroundings to enable them to enjoy life there.

These are all simple things, but important. It seems in this case that the superior stability of the Czechs arises from their group cohesiveness and group attitudes put into practice, and that the greatest need among the native American farmers is group organization, good group leadership, and definite group objectives. Whether these things may be brought about among the "individualistic" native American farmers of Lincoln County—and other declining farm areas—is quite another problem.

THE NEW BRIGHT TOBACCO BELT OF NORTH CAROLINA

Parnell W. Picklesimer

IN this study of the New Bright Tobacco Belt of North Carolina several facts and relationships of interest to the regional geographer are revealed. The region lies almost wholly within the Inner Coastal Plain of the state, and embraces a territory of nearly 5,000 square miles (Figure 1). The area has been set apart as a regional unit largely on the basis of its present land use. The purposes of this study are to determine how man has occupied and used the land, to account for the changes that have taken place in the use of its resources, and to suggest problems which are likely to await solution in the near future.

Occupance

The New Bright Tobacco Belt, as this region is called, has been revolutionized within the span of about three hundred years. From a land of native vegetation and wild life has evolved a life of forest industries, followed by a subsistence agriculture and livestock industry of the forest and, finally, an agriculture devoted largely to the production of cash crops. From a study of the trends in agricultural commodities, it is clear that subsistence agriculture prevailed until about the time of the invention of the cotton gin in 1793, after which time an increasing amount of attention was given to cotton and tobacco. The production of tobacco on a commercial scale, however, did not make much progress until after about 1890. It was not until after the opening of the present century that there was a slight tendency on the part of farmers to diversify their productions. Each culture set its own peculiar stamp upon the region.

The Indians occupied the area until about 1722, but they utilized few of its resources. The early white settlers made their homes along the streams, and expanded gradually to the interstream sections. During the colonial period the settlers earned a livelihood chiefly through the cultivation of the soil, the raising of livestock, and the development of a naval stores industry. Farming was first conducted on the terraces along the rivers, and the productions consisted of subsistence crops. The livestock industry, although an industry of the forest, was proportionately more important than any other in the history of the region. While there were many oaks, the region was mainly an area of pine forests, from which naval stores were secured and exported.

Character of the Landscape

The New Bright Tobacco Belt is a low plain with a slight tilt toward the southeast. The elevation drops from 335 feet along the Piedmont border to almost sea level at one point along the eastern edge. The topography is fairly smooth and there is scarcely an outcrop of bedrock to be seen except along the western margins and at one place near Rocky Mount. A pilot flying at a high altitude over the region looks down upon what appears as a vast flat sea of land, with wide expanses and considerable distances. While there is a certain monotony in the landscape, the surface seems patterned with alternate forests and cleared fields, and towns and villages are rather uniformly spaced. Over all is a network of streams, railroads, and paved and unpaved roads.

To a traveler on the ground the picture is different. His vision is obscured

FIGURE 1.—Map of North Carolina showing the location of New Bright Tobacco Belt.

by vegetation beyond the roadside fields; all seems close at hand, and spaciousness does not exist. To the occasional visitor the whole area—its physical attributes and its life—is known only in spots. But a careful study of existing maps and many inspection trips through various portions of the region will reveal that it is plainly a land of contrasts. This is fundamentally due to the Pleistocene terraces of which the region is composed (Figures 2, 3, and 4). These terraces are separated by low scarps, which represent former shore lines. Approximately three-fourths of the area is mildly undulating upland which contains the cultivable land, and the remainder is largely made up of boglands, unsuited to agriculture but sometimes used for grazing, especially during dry periods (Figure 5). The region, on the whole, does not have a trim appearance. Those finer adjustments found in more highly developed farm areas have not been made here.

LAND USE

Agricultural activities are at present dominant in the region and are related to, and in part limited by, such factors of the natural environment as topography, climate, soil fertility, native vegetation, and transportation facilities.

There are several factors which favor agricultural production. The surface of the land is fairly smooth and largely devoid of stones. The climatic conditions are such as to favor a variety of lower middle-latitude crops. The dominant and most normal soil of the region is the group known as the Norfolk sandy loams and these are moderately well drained and easily tilled. A survey of the native vegetation also indicates that a considerable variety of crops can be grown.

On the other hand, there exist certain conditions which are not favorable to agricultural production. Approximately one-fourth of the region is made up of poorly drained boglands, which are unsuited to agriculture. Most of the land, including the so-called uplands, is so flat and of such low elevation, that artificial drainage becomes a farm necessity. The soils are badly leached, and are not what one would call first-rate soils. The area apparently remains an important agricultural section largely because of the continued use of commercial fertilizers. Furthermore, a few troublesome weeds are found to harass the farmer, such as field garlic, bitterweed, poison ivy, cocklebur, field bindweed, nut grass, and Johnson grass, which reduce crop yields and endanger farm values.

Natural environmental factors largely

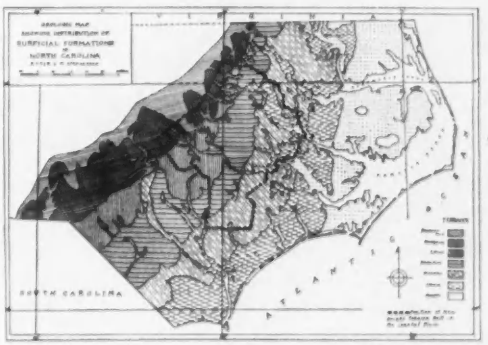

FIGURE 2.—Map showing location and distribution of the Pleistocene terraces in eastern North Carolina.

FIGURE 3.—Landscape on the Sunderland Terrace.

determined the methods and routes of travel and transportation. The area is interlaced with streams and swamps and, because it was at first easier to travel by water than by land, the early settlers occupied the most favored locations on or near the navigable streams. As interest grew in cotton and tobacco, people tended to shift from the riverine to the interstream sections, where conditions were more favorable for these crops. Roads came slowly into existence, and it was not until 1929 that an adequate system of hard-surfaced highways was provided (Figure 6). Although there is at present a fairly good railway pattern, the circulation of the area depends largely on roads (Figure 7).

Unimproved land comprises a large percentage of the area of every county in the Belt, and constitutes about 66.1 per cent of the total land surface. The unimproved land is largely in timber, much of which is now inferior in kind and quality, and represents (1) lands too wet to attempt clearing and draining for agricultural use; (2) abandoned fields which have reverted to forest or are in the process of so doing; and (3) a small amount of land which could be cleared and drained with profit. The first two classes comprise practically all the unimproved land. The area embraced in class one is remaining constant, but in class two it is increasing. Some of class three lands are being cleared. In recent years there has been an increase in the acreage of unimproved land, which is probably due to a greater emphasis being placed upon small-acreage cash crops, and the reluctance of farmers to diversify their productions

The forest industries are the region's second most important industry. There are at present 174 forest industry-plants, and these are distributed throughout every county (Figure 8). The industry is dominated by small portable sawmills, operating largely in second growth timber, and averaging a change in location about four times a year. Important mill products are lumber, cross ties, and veneers.

The location and diversity of markets for forest products favor production. The large consuming centers of the

FIGURE 4.—Landscape on the Wicomico Terrace.

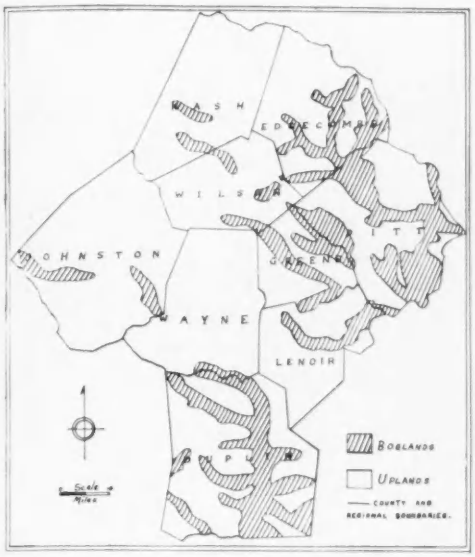

FIGURE 5.—Map showing location and distribution of boglands and uplands in the region.

Northeast are within truck haul of this region. The furniture industry of the near-by Piedmont area of the state provides a market for hardwood lumber and veneers. There is also a demand for hogsheads, boxes, crates, and baskets in which to market tobacco and vegetables. There appears to be an excellent opportunity for a pulp mill to locate here that would use gum as raw material.

During the past forty years the following changes have occurred in rural conditions: (1) there has been an increase in the number of farms; (2) there has been a marked decrease in the size of farms; (3) there has been a slight decrease in the amount of improved land in farms; and (4) farm land has increased greatly in value. The increase in the number of farms was largely due to the subdivision of previously existing farms with an accompanying reduction in the size of individual farms. The kinds of cash crops grown do not call for an expansion of the existing cropped area, both cotton and tobacco being small acreage crops. Since 1900 land values have increased 460.3 per cent; however, the depression years of the early thirties reduced these values to new low levels from which they have not completely recovered.

The leading crop productions in the Belt are tobacco, cotton, corn, peanuts, soy beans, hay, and vegetable truck crops. More time and attention are given to cash crops than to subsistence crops. This is largely due to the fact that the soil is well adapted to the growing of cotton and tobacco, especially cigarette tobacco (Figure 9). The farmer devotes most of his attention to the production of tobacco, from which he receives the major portion of his cash income (Figure 10 and 11). This results in most farmers being compelled to import considerable quantities of corn, hay, vegetables, meat, and dairy products. The livestock industry also makes a poor showing in the region. Every year the packing houses of Chicago ship hundreds of thousands of pounds of meat into the Belt. It may be said, however, that a diversified agricultural program is slowly developing.

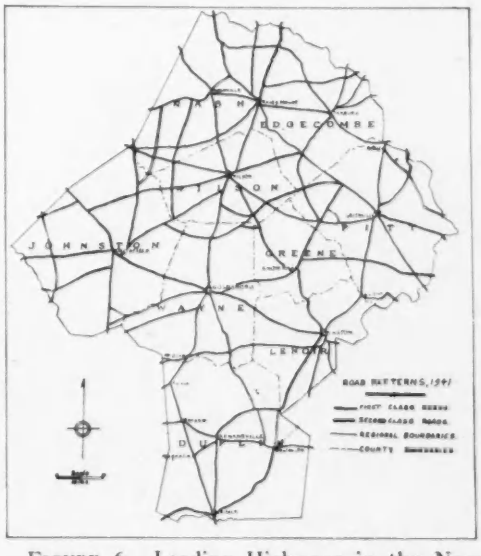

FIGURE 6.—Leading Highways in the New Bright Tobacco Belt.

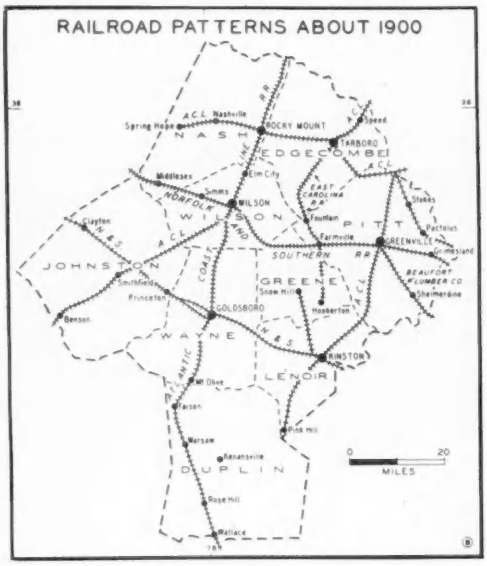

FIGURE 7.—Railway patterns in the region in 1900.

At present nearly 32 per cent of the total population lives in agglomerated communities. These communities function chiefly as trade centers, markets for farm products, and seats of government (Figure 12). Their growth in population, like that of the rural areas, has been greatest during the past four decades. An awkward feature of the tobacco marketing towns is found in the great rush of business during the fall, followed by the lean months of winter, spring, and summer.

The present utilization of the land reflects to a large extent the use for which the land is suited. It would appear, however, that greater emphasis should be placed upon the production of food and feed crops, the development of which is slow because of inadequate markets and the lack of a system of standards for grading many farm products. The development of such a program is also held in check by the greater demand for bright tobacco. Another problem which seems ripe for solution pertains to the forested areas. The tax rate on forest land is too high in proportion to that of the cultivated areas, a practice which is discouraging to forest conservationists and often compels the cutting of timber before it reaches the proper stage of merchantability. There is also a greater need

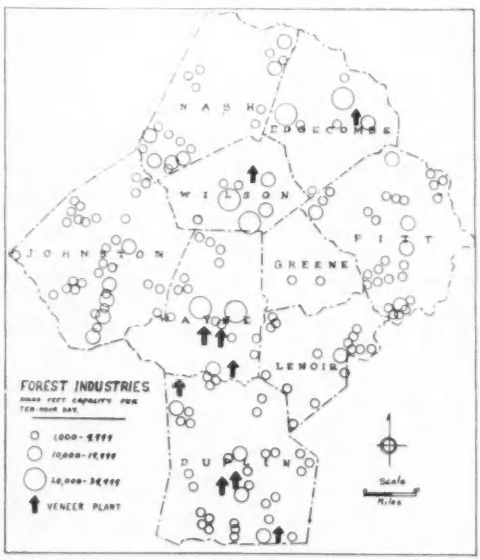

FIGURE 8.—Map showing location and distribution of forest industries in the region.

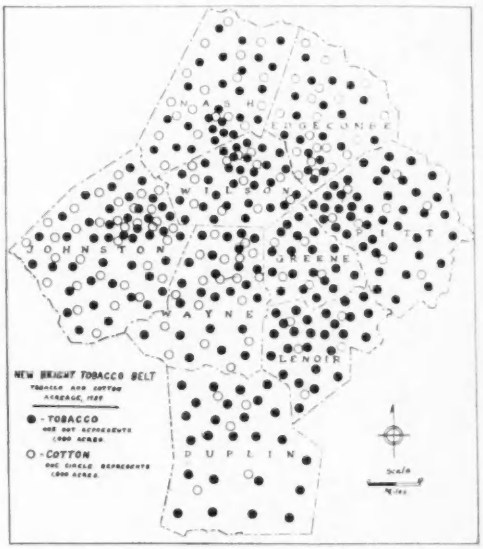

FIGURE 9.—Tobacco and cotton acreage distribution in the New Belt.

FIGURE 10.—One farmer's supply of fuel wood for curing tobacco.

for protection of the forests against fire than exists at the present time.

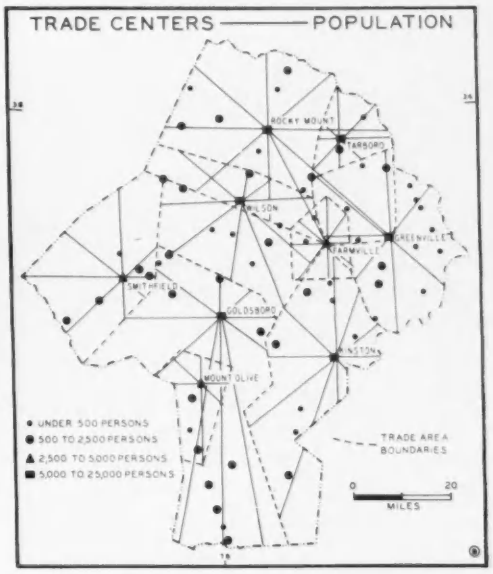

FIGURE 12.—Map showing location of trade centers and areas they serve.

FIGURE 11.—A tobacco bed in the New Belt.

THE BULB INDUSTRY OF WESTERN WASHINGTON

J. P. Galvin

LONG associated with the Netherlands, bulb growing is one of the most spectacular and most highly specialized types of agriculture.

Ever since 1593 when it was introduced from Persia, the Netherlands has had virtually a monopoly on the production of tulip, as well as narcissus and hyacinth bulbs. During the bulb craze in 1634 fortunes were made and lost in one of the most famous orgies of speculation the horticultural world has ever known. Bulbs commanded fabulous prices, and tulips were worth their weight in Dutch guilders. There is the story of the careless daughter who unwittingly fed her father's $2,000 prize bulb to a beggar for an onion. Hungry Hollanders, and their uninvited German guests, are again eating tulip bulbs, said to be a valuable source of vitamins. They are also reportedly removing the poison from narcissus, drying and grinding the bulbs for use as a coffee substitute.

Of the many Dutch industries dislocated by war, two have been transplanted to the United States: diamond cutting, located in New York City, and bulb growing, largely concentrated in the state of Washington. The United States now produces ninety-five per cent of all the narcissus in the world, and more than half of this crop is grown in Washington.

Most of the flower bulb growers in this country either came directly from Holland or are of Dutch ancestry. Nationality is clearly indicated by names of some of the Washington growers: Van Zanten, Van Zonneveld, Wimer, Gronen, Kanouse, Orton, Chervenka, Goelzer, De Vries, Staatz, Janig, and Van Lierop.

Beginning of Bulb Industry

With an industry worth well over one million dollars annually, Washington is the largest bulb producer in the United States. Credit is given to Mr. George Gibbs, native of England and resident of Whatcom County, for having conceived the idea of a bulb industry in western Washington as well as for much of the initial experimental work. He imported bulbs of several varieties and after some years of experimentation came to the conclusion that bulbs as fine as any in the world could be grown in the Puget Sound region. As a result of his pioneer work the U. S. Plant Introduction Field Station was established on the "Guide Meridian" north of Bellingham in 1907.

Narcissus, for many years the most widely grown bulb (Figure 2) in the state of Washington, is native to Central Europe and the Mediterranean region and eastward through Asia to China and Japan. Many specie names appear in literature, most of them representing variants of hybrids because the plants have been widely cultivated and have received much attention from fanciers. Probably twenty-five or thirty species represent the original stocks. The hyacinth, which occupies a smaller acreage, was native to South Africa though apparently took its name from Greek mythology.

The main bulb growing area of Washington extends from Lynden to Fargo

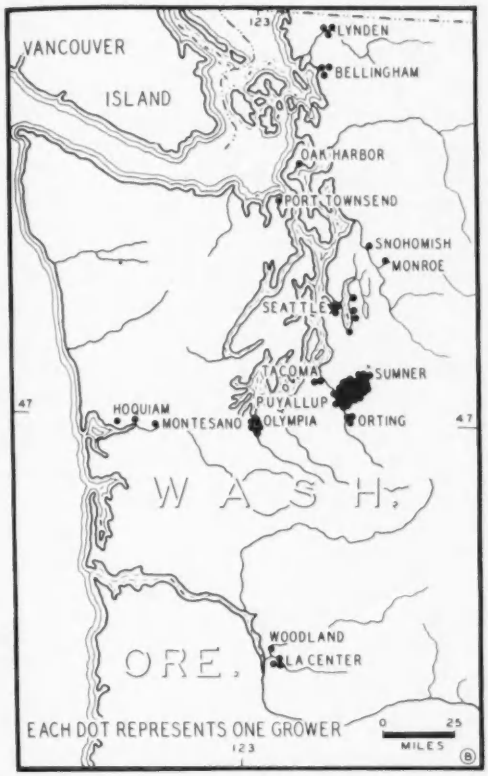

FIGURE 1.—Bulb growing areas of Washington. Each dot represents one grower (regardless of acreage). There are 83 commercial growers in Western Washington.

Lake, a distance of about three hundred and fifty miles. It includes (1) the Puyallup Valley area—Puyallup, Sumner and Orting; (2) the area around Bellingham, including Lynden and vicinity; and (3) the Fargo Lake region around Woodland and La Center (Figure 1). These three areas are the largest producers but bulbs are also grown commercially in other parts of western Washington.

Acreage planted to bulbs includes: narcissus, approximately 1200 acres, tulips 250 acres, hyacinth 4 to 5 acres, iris 400 acres, and lilies 30 acres.

ENVIRONMENTAL REQUIREMENTS

Ideal weather conditions for the propagation of bulbs are found in western Washington where there is neither extreme cold in winter nor extreme heat in summer and where precipitation (minimum 34 inches) is well distributed through the growing season which extends from the end of September to about the middle of July but no month is entirely without precipitation. Good drainage is absolutely necessary or the bulbs will rot in the ground.

The soil required is of the sandy loam type, very friable and with a minimum depth of fourteen inches, the top soil being underlain with good drainage material. Farms are, therefore, located in flat, well drained country (Figure 5) out of the hard freezing area (Figure 1). The soil is fertile but with a minimum annual rainfall of 34 inches leaching is a problem. Approximately eight hundred pounds of fertilizer (a mixture of super phosphates, potash, and ammonia) is required per acre. To strengthen and enrich the soil about half of the growers use vetch as a cover crop in combination with their regular rotation plan. Tulips must be lifted (moved or rotated) each year or they will develop a disease known as "fire."

Bulbs grown on the higher lands tend to be somewhat smaller and a little firmer than those on the lower lands. However, the larger and softer lowland bulbs are equally good in quality.

LABOR REQUIREMENTS

Planting and cultivating the bulbs, weeding, cutting the flowers, digging and curing the bulbs requires much labor. Hyacinths require the additional work of "scooping and scoring" or artificial propagation. Irrigation is not practiced, hence frequent cultivation is necessary in order to conserve moisture.

Both planting and harvesting require a large amount of hand labor. Depending upon the size of the bulb and the experience of the planters, one man can

FIGURE 2.—A field of narcissus in bloom, 1943.

plant by hand from one-fifth to one-half acre a day but the average is about one-third of an acre a day.

Devices for lifting the bulbs are available but each grower has either developed his own digger or digs the bulbs by hand. Mechanical diggers are interesting machines which in some cases required real skill in their development. One of the most satisfactory diggers I have seen consisted of a small plow blade set so that it dug about five inches into the ground; directly behind this blade there was a scoop arrangement which as the bulbs were dug transferred them to a slowly rotating cylinder, constructed of wire rods about one-half inch apart, where dirt was removed from the bulbs before they fell into bushel baskets. The machine was drawn by a tractor.

Before bulbs are packed they must be cleaned of soil, if this has not already been done mechanically. They are then sorted and graded and the inferior or diseased bulbs removed and destroyed. Sorted bulbs are placed in trays which are four feet long, two feet wide, and about five inches deep, the sides and bottom is slatted to allow free passage of air and curing. Each tray holds approximately seventy pounds of bulbs. The trays are placed in racks in open-ended sheds with slatted sides, each shed holding about six thousand trays. Before bulbs are shipped they must be cured (usually one to one and a half months), sprayed, powder dusted, fumigated or hot water treated, depending upon the disease that is being fought and the prophylaxis used.

Bulb growers have a relatively large capital investment for many thousands of bulbs must be purchased at a cost of from three to fourteen cents per bulb, depending upon the bulb type; furthermore, three to six years must elapse before the bulbs start reproducing themselves so that they may be sold. An increase in the wage scale from thirty-

FIGURE 3.—The blossoms have been removed from this field of narcissus to prevent the bulbs from expending their energy in making seeds. Note the blossoms on the ground between rows.

five to forty-five cents per hour prior to 1942 to the current rate of sixty-five to seventy cents per hour has added to the cost of production. In the Puyallup Valley where Filipinos have been used for the back-breaking labor of planting the bulbs, labor is now very scarce at any price and extensive experiments are being made in planting bulbs by machinery. To date there is no satisfactory method for mechanically placing bulbs in the ground with their crowns in the correct vertical position.

In getting an acre of tulips into production, the estimated cost of planting stock is $2,000 and the work of planting and growing from $300 to $350. Narcissus is slightly less expensive with estimated cost of planting stock $1,500 plus planting and growing, from $250 to $275 per acre. Net return per acre is influenced by additional factors, such as buildings and equipment, but it seems that a fair estimate would be from $300 to $350 per acre net.

FIGURE 4.—A close-up of narcissus—note the soil texture.

Work Schedule for Hyacinths, Narcissus and Tulips:

Plowing	August
Planting	Sept. 15-Nov. 15
Mulching	November
Lifting of mulch	Jan. 15-Feb. 15
Cultivation	Feb.-July
Blooming period	March 15-May 1
Digging (lifting)	July 15-August
Sorting and grading	August-December
Marketing	November-January

Bulbs are usually planted in a flat furrow four inches deep. Because of the occasional cold weather in the Bellingham area, an oat straw mulch must be used. About six hundred pounds of straw are placed on one acre of ground, to a depth of about one inch. This mulch is removed about February first.

It is generally believed that cutting either the leaves or the flowers allows water and soil to get to the bulb itself by way of the hollow stem and this causes the bulb to rot. Only the blossom is picked (Figure 3) when it has wilted; this is done so that the bulb will not expend its energy making seeds. Blooms to sell are not cut from regular stock but are taken from cutting stocks grown especially for this purpose. The blooming peak of narcissus (Figure 4) is from March first to April first, depending upon the variety. Tulips and hyacinths follow three to four weeks later. There are actually three distinct blooming times: that of the Woodland and Lake Fargo area being a week to ten days earlier than the Puyallup Valley, while the Bellingham area is correspondingly later.

MARKETING

About ninety per cent of all Washington tulip and narcissus bulbs are used in the greenhouse forcing trade. The most popular bulb varieties for the florist trade consists of "King Alfred"

FIGURE 5.—A field normally used for bulb growing. Note the extreme flatness of the valley bottom.

narcissus, single red tulips, and hyacinths in pink, white and blue. Eighty-five per cent of the narcissus grown is of the "King Alfred" variety. Most tulips have only one bloom while narcissus bulbs the first year usually have no blooms; the second, one; the third, one to two; and the fourth year, three. It is in the fourth year that the bulbs are usually sold.

From 150 to 175 carloads of bulbs are shipped out of the state each year and most of them are marketed in eastern United States, the largest shipments going to New York and Chicago. The Puget Sound Bulb Growers Exchange markets part of the crop but many of the larger growers regularly go east in early spring to contract for the sale of their crops.

Prior to the war both Holland and Japan were serious competitors of the bulb industry in this country. In 1939 over $1,600,000 worth of tulip bulbs alone came from Holland, but in 1940 imports dropped to $22,000. At present all the bulbs used in the United States are grown here. In addition to western Washington, bulbs are raised commercially in Michigan, Oregon, and Long Island.

The demand for bulbs is increasing but in order to contribute to the war effort, 750 to 1,000 acres of former bulb ground are now producing vegetables, vegetable seeds, potatoes, and hay.

FREIGHT RATES AS A GEOGRAPHIC FACTOR IN ILLINOIS

John W. Alexander, U.S.N.R.

THE distribution of features on a geographic landscape is determined by two types of factors—physical and cultural. The more important physical factors are landforms, climate, and natural resources; of a cultural nature are the racial, political, and economic factors. These two types of controls combine to determine the distribution of those features which man locates on the geographic landscape.

Just as rainfall is one of the important climatic factors, so freight rates are an important economic factor influencing the location of industries and certain types of agriculture. And it just as possible to map an area to show the distribution of freight rates as it is to show the distribution of rainfall.

The purpose of this study is twofold: (1) to present a series of maps showing the freight rate structure in the State of Illinois on shipments of certain commodities to the major markets by railroad, and (2) to show the relationship of this railroad freight rate structure to the location of certain types of agriculture.

Construction of these freight rate maps was based on rates quoted in the tariffs of twenty-two railroads. Figure 1 shows the structure of grain rates from all points to Chicago. The isarithms connecting points of equal freight rates are known as "isophors." On the maps in this article, the isophors are drawn through the points nearest the market; that is, on Figure 1 the towns nearest Chicago having a 13-cent rate to Chicago are connected by the 13-cent isophor; hence all points between this osophor and the 12-cent isophor have a rate of 12 cents. In Figure 1, the low value isophors from the 6-cent rate through the 11-cent rate are arranged more or less concentrically around Chicago, indicating that generally rates increase at the same tempo in all directions. The 13-cent isophor loops far to the south; directly west of Chicago the increase is very irregular. The most significant aspect of this map is the expanse blanketed by the 12-cent rate. From a narrow strip in the north it expands southwards to a maximum width of approximately 125 miles. As a result, points in east-central Illinois have a much more favorable rate on grain into Chicago than do points of equal distance to the west.

Figure 2 shows the State's structure of grain rates to East St. Louis. The striking feature of this map, as was the case on the Chicago map, is the capricious path which the 13-cent isophor strikes across the State. From a point on the Mississippi River only sixty miles from East St. Louis, this isophor runs north-east to a maximum distance of 190 miles from the market and blankets with a 12-cent rate much of the same area in eastern Illinois which is covered by the broad 12-cent rate in the Chicago structure. The 14- and 15-cent isophors also break across the State so as to favor the east. A comparison of rates from two points equidistant but in different directions from East St. Louis emphasizes the eccentricity of this structure: the northeast

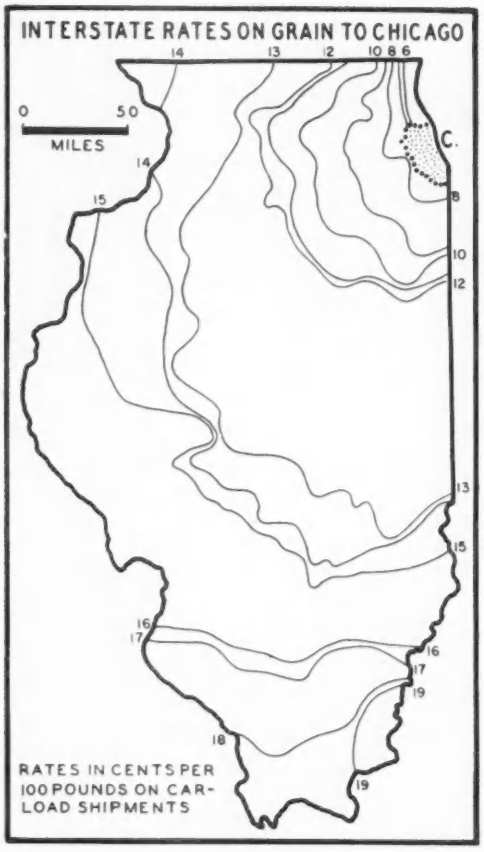

FIGURE 1.—Interstate rates on grain to Chicago (rates in cents per 100 pounds on carload shipments).

lobe of the 12-cent rate area is farther away than parts of western Illinois having a 16-cent rate.

East central Illinois also enjoys more favorable rates to the eastern markets than does the western part. Two of the largest grain markets in the mid-west are Evansville and Indianapolis, Indiana; and simply because of proximity, eastern Illinois has an advantage in rates.

The question can be asked if there is any relationship between these grain rate structures and the production of grain in the State. Since corn is by far the most important grain grown in Illinois, a map was constructed to show the distribution of corn production (Figure 3). It will be seen that the northern half is in the heart of the Corn Belt and the production of corn is rather evenly distributed in a broad band across the State. Yet the emphasis is not on corn as a money crop throughout this area; in the east the most important type of agriculture is cash-grain farming, but in the west the emphasis is on livestock and only a small percentage of farm income is from the sale of grain. Figure 4 shows that most of the corn shipped from the farms and sold as grain comes from the eastern two-thirds of the State—the area enjoying the favorable rates on grain shipments in the three rate structures: Chicago, East St. Louis, and the East. In western Illinois the corn crop is disposed of in another way—fed to animals which are then shipped out.

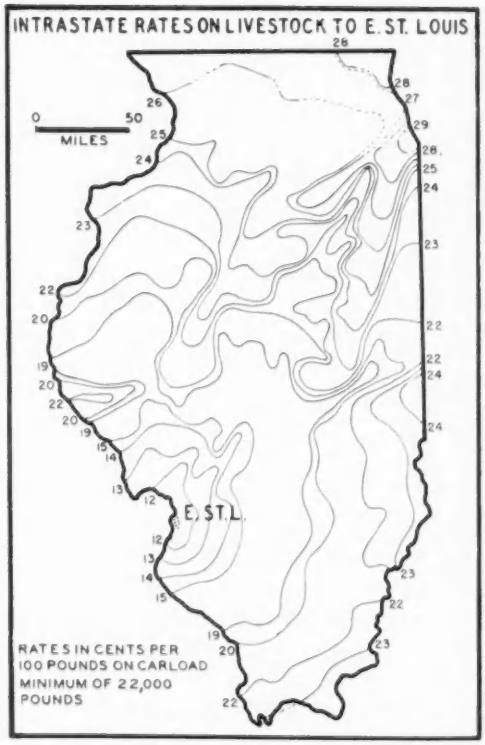
INTRASTATE RATES ON LIVESTOCK TO E. ST. LOUIS
0 50
MILES
E. ST. L.
RATES IN CENTS PER 100 POUNDS ON CARLOAD MINIMUM OF 22,000 POUNDS

FIGURE 2.—Interstate rates on grain to East St. Louis (rates in cents per 100 pounds on carload shipments).

We shall see that just as the grain rate structure favors eastern Illinois, the livestock rate structure favors the west.

Figure 5 shows interstate rates on livestock shipments to Chicago. Livestock rates are higher than grain rates because (a) insurance rates are higher since there is danger of injury to the animals, and (b) much less weight is represented by a carload of livestock since they cannot be packed in as densely as grain. On this map the isophors run from the Indiana line concentrically around Chicago until a line connecting Chicago–Peoria–Illinois River is reached; here they all (beginning with the 17-cent rate) swing sharply to the south paralleling this line for a long distance before turning westward. The 21-cent isophor may be cited to illustrate the advantage which the west enjoys; some western points covered by the 21-cent rate are almost twice as far from Chicago as corresponding points in the east.

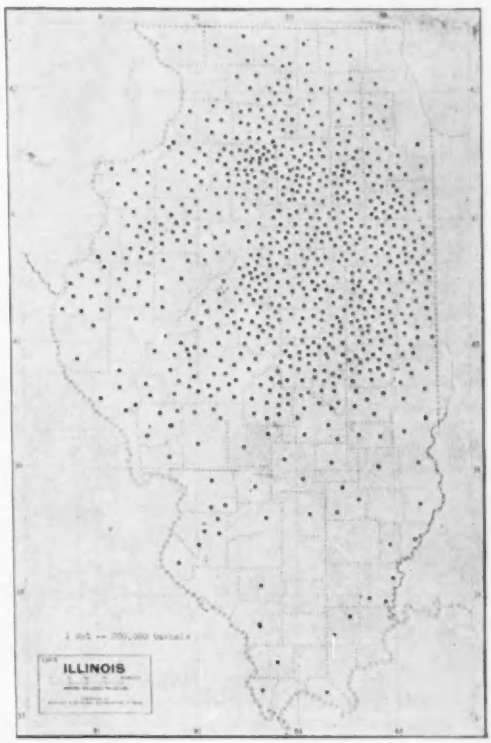

FIGURE 4.—Corn sold in Illinois, average for 1939 and 1940 (one dot represents 200,000 bushels).

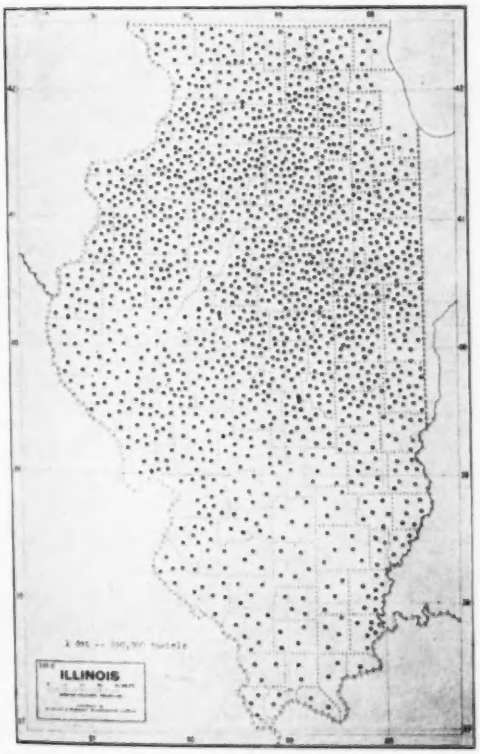

FIGURE 3.—Corn grown in Illinois, 1939 (one dot represents 250,000 bushels).

The rates in Figure 5 are "interstate rates" applying on shipments destined through Chicago to points outside the State. These rates are supervised by the Interstate Commerce Commission. But much of the livestock shipped from Illinois are destined for Chicago or East St. Louis, hence the movement is entirely intrastate, and the Illinois Commerce Commission (which has jurisdiction over railroad intrastate rates) allows the roads to quote lower rates on intrastate traffic to meet motor truck competition.

Figure 6 shows "intrastate rates" on livestock into Chicago. The rates plotted on this map apply on livestock which is brought by the farmer to the

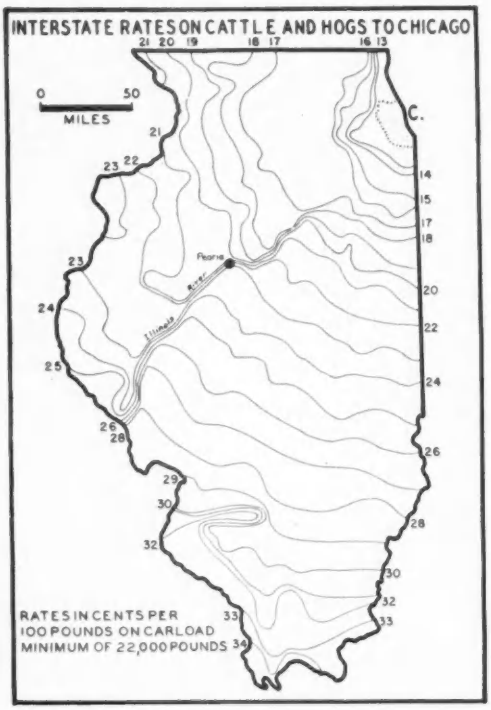
INTERSTATE RATES ON CATTLE AND HOGS TO CHICAGO
21 20 19 18 17 16 13
0 50
MILES
C.
Peoria
RATES IN CENTS PER 100 POUNDS ON CARLOAD MINIMUM OF 22,000 POUNDS

FIGURE 5.—Interstate rates on cattle and hogs to Chicago (rates in cents per 100 pounds on carload minimum of 22,000 pounds).

railroads' stock pens along the line; that is, no pick-up service is considered. The 10-cent isophor indicates an immediate preference for western Illinois. The succeeding isophors continue to increase the ratio between their westward extension and the distance they penetrate southward. The extreme is reached by the 17-cent line which is only 85 miles from Chicago at its maximum distance to the south but is 180 miles from Chicago where it crosses the Mississippi River. The 18-, 19-, 20-, and 21-cent isophors also are as preferential. Not only interstate rates but also intrastate rates on cattle and hog shipments to Chicago are partial to the west.

The structure of intrastate cattle rates to East St. Louis is shown in Figure 7. As a whole, western Illinois has an advantage on livestock rates to this market.

In passing, one cannot help but be impressed with the amazing irregularity and inconsistency of the livestock rate structures in contrast to the grain rates. The isophors on the grain rate maps trend across the State in a smooth and rational patterns; lines on the livestock rate maps are in a jumbled mass of disorder. The reason for this is that truck competition has wrought havoc with the railroad livestock rate structures. Railroads which serve Chicago and East St. Louis directly have cut their intrastate rates to meet truck competition; other roads have not lowered their rates. Trucks have made greater inroads in the railroads' livestock traffic than grain traffic because the

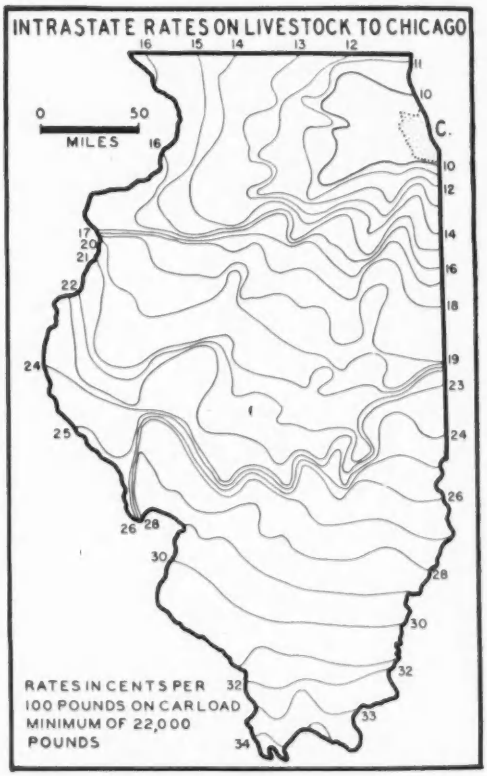
INTRASTATE RATES ON LIVESTOCK TO CHICAGO
16 15 14 13 12
0 50
MILES
C.
RATES IN CENTS PER 100 POUNDS ON CARLOAD MINIMUM OF 22,000 POUNDS

FIGURE 6.—Intrastate rates on livestock to Chicago (rates in cents per 100 pounds on carload minimum of 22,000 pounds).

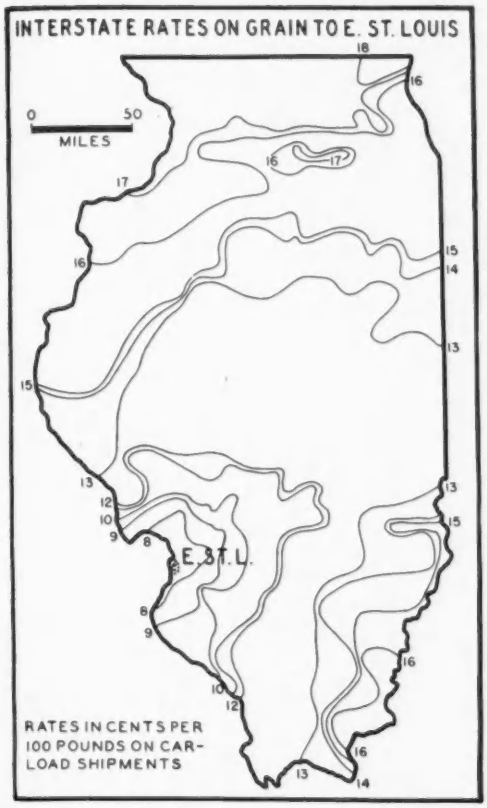

FIGURE 7.—Intrastate rates on livestock to East St. Louis (rates in cents per 100 pounds on carload minimum of 22,000 pounds).

former is more easily adapted to truck movement. Livestock is not "harvested" at one short season of the year as is grain; instead, it is continually being "finished off" and marketed throughout the year. Thus, a farmer might have only a few head of stock at a time to ship; these few might not fill a railroad car (and higher rates are charged unless the shipment totals at least 22,000 pounds) but they might make a truckload. Therefore the producer is encouraged to send small cattle shipments by truck.

The percentage of livestock moving to markets in trucks has steadily increased the last ten to fifteen years. As a result, the significance of the structure of railroad livestock rates is constantly decreasing especially for short hauls. A very high percentage of livestock traffic from points within 150 miles of the market moves by truck.

A second phase of the freight rate structure which favors the cattle business in western Illinois is the "feeder rates." Much of the cattle shipped from this part of the State is known as "feeder stock," which originates in the western states and is stopped in transit to Chicago to be fattened on Illinois corn. On this type of traffic a special "feeder rate" is charged from the originating point to the fattening point; this rate is 85 per cent of the regular interstate rate. Cattle shipped straight through from the western ranges to the market's slaughtering plants arrive in a condition which does not draw as high a price as if they have been stopped for fattening just before reaching the market. However, if this stopping-in-transit is done under regular rates, the full interstate rate would be charged from the range to the fattening point in Illinois; and then a few months later a full intrastate rate from this point to Chicago would be assessed. "Feeder rates" encourage the fattening of cattle on Illinois farms.

It has been pointed out that the structures of livestock rates to both Chicago and East St. Louis are more favorable to western Illinois. Figures 8 and 9, showing the distribution of cattle and hogs respectively, indicate a decided concentration in the west—the area enjoying the favorable rates.

SUMMARY

The structures of grain rates favor the east; livestock rates favor the west and northwest. Corn production is almost as heavy in the northwest as in the east, but the disposition of the

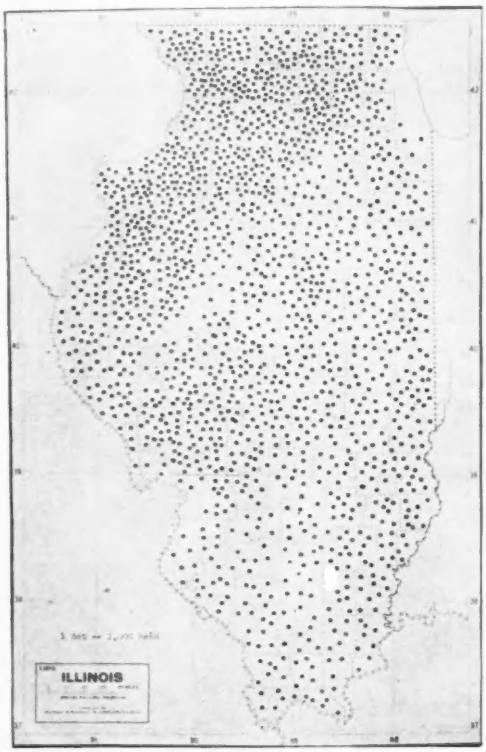

FIGURE 8.—Distribution of cattle (excluding milk cows) January 1, 1940 (one dot represents 1000 head).

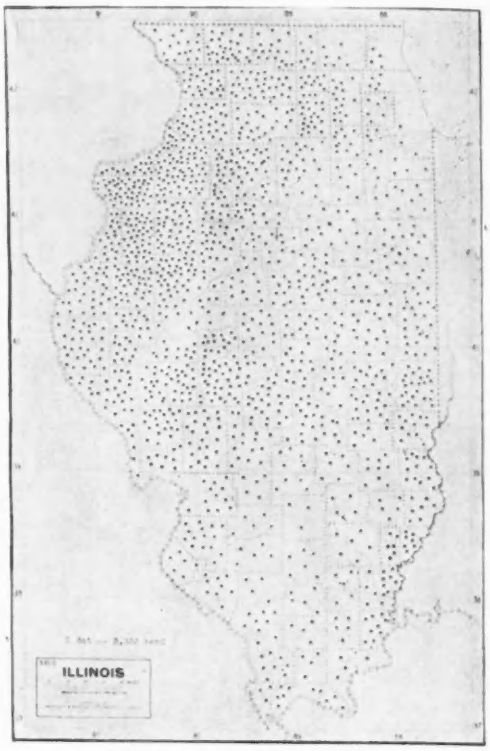

FIGURE 9.—Distribution of hogs, January 1, 1940 (one dot represents 3,333 head).

crop differs in the two regions. The emphasis is on livestock in the former and on cash-grain in the latter. It is not contended that the freight rate structures *cause* this distinction, but they definitely *favor* it. As far as freight rates are concerned, it is more profitable for a farmer in eastern Illinois to market his corn as a cash-grain; similarly, it is more profitable for western farmers to feed their corn to stock and market the corn "on the hoof."

POPULATION DISTRIBUTION IN WEST VIRGINIA

Robert L. Britton

GENERAL statistics concerning the population of West Virginia require considerable careful research for correct interpretation. The total population in the state in 1940 was 1,901,971; the average density was seventy-six per square mile. The largest city in the state, Huntington, had a population of 78,103. The disparity between the rather large total and the square mile density of population, as compared to the small size of cities in the state, has puzzled many. The purpose of this article is to give a general picture of historical, economic, and natural factors leading to present population distribution, to explain some of the seeming paradoxes in general statistics, and to discuss the major factors of development in areas having a density of over four-hundred people per square mile (Figure 1).

With the exception of its eastern panhandle, much of West Virginia's population backed into the state from the west and north. The gaps in the Appalachian mountain and plateau region led to the south of West Virginia into Kentucky and Tennessee, or to the north of the state into Pennsylvania. Later these streams of population converged along the Ohio River and began backing up the numerous Ohio tributaries into the dissected plateau which comprises much of the area of West Virginia. This fact goes a long way in explaining the lateness of West Virginia in developing considerable densities of population, important regions for extraction of natural resources, and later still, industrial areas. West Virginia's population was widely scattered at the time of statehood, 1863, and there were no great local densities until many years after the Civil War. Indeed, the greatest densities have developed since 1900 (Table 1).

Valley Settlement

A majority of the large concentrations of population in West Virginia are where original white settlement started, that is, valleys, chiefly river valleys. Many of the early advantages of valley location still exist and are in most instances enhanced by later economic development. Tremendously important new advantages of valley location of settlement have been added from time to time.

Some early advantages of valley location were: easier travel by land or water, abundance of game, better soil and less difficult clearing for subsistence agriculture, abundant wood for fuel and home construction, water power for grist mills, domestic water supply, and the like.

Smallness of Towns

A majority of West Virginia's towns were established where transportation routes joined, largely river junctions, in the early days of settlement in the region now comprising the state. Corporation limits were set in times of small population concentrations. This is the main explanation of the present small size of West Virginia towns in comparison with the larger total and square mile densities of the state as a whole. A large percentage of the present industrial activity in the state is just outside corporation limits. (This is the reason for the use of the word "area" with city

names in this article.) As an example, Wheeling has a city population of only 65,000, but it is the urban center for a quarter of a million people in nearby areas. This is true in less degree of the other dense population areas discussed in this paper.

Since the original valley pattern of settlement was worked out as described above, the thickening up of dense areas of population in the state has been caused by a series of developments of one of the great natural resources of the state after another. All these were approached from valley locations, thus continuing and adding to previous valley concentrations of the people.

INDUSTRIAL INFLUENCES

The salt industry in the Kanawha River valley was one of the first in a series of developments of natural resources. Salt evaporation, transportation, and sale developed into considerable frontier significance in the late 1700's and early 1800's. This resource is still of major importance as a raw material in the great concentration of the chemical industry in the Kanawha Valley near Charleston (Figure 1).

One difficulty of the early salt industry was a bubbling gas and oil film on the brine of some of the bored salt wells. Soon native ingenuity devised a use for the gas as a fuel for reducing the salt brine into crystals. From this beginning, gas production developed into a resource of tremendous importance as domestic and industrial fuel in the state. Large quantities are piped out to other states. While gas production led to no densities of population in itself, it has contributed to the development of many industries in the state to which it is ideally suited as a fuel. Glass, pottery, chemical, metallurgical, brick, and others employ this cheap fuel in enormous quantities. The employees of these concerns help swell the densities of population in the Wheeling, Moundsville, Morgantown, Fairmont, Clarksburg, and Huntington industrial areas.

Oil, at first a hindrance to salt operations, attracted commercial attention in the West Virginia area in the early days of the Civil War. A Confederate raid was made on the Burning Springs area to destroy this oil supply which was being used by the Union forces. Soon after the war production was rapidly increased and reached a peak of 16,000,000 barrels in 1900. The industry has declined to about one-third of its former production, but a refining industry of considerable importance continues, using local plus western pipeline oil. This contributes to the population concentration in Parkersburg, Clarksburg, Wheeling, Charleston, and Huntington areas (Figure 1).

IMPORTANCE OF COAL

Coal is by far the most important natural resource in West Virginia. Directly and indirectly it supports two-thirds of the population of the state. Although coal was discovered in this region by George Washington and others in his time, real development on a large scale began during post-Civil War reconstruction. Rail and, later, highway transportation development paralleled the growing coal industry, each leaning on the other as an indispensable adjunct. Many of West Virginia's major population areas such as Bluefield, Williamson, Logan, and Beckley (Figure 1) are largely explained by their position as transportation and merchandising centers for important coal fields. Although coal is an extractive industry, the enormous tonnage of production in West Virginia (well over 100,000,000 tons per year) requires the services of a large number of workers. Williamson, for example, with a population of 15,000,

is the retail and shipping center for an area of dense population totaling around a quarter of a million people.

Coal is a major factor in the development of every other dense population area in the state. The industrial development of Wheeling, Charleston, Fairmont, Morgantown, Clarksburg, and, to a lesser extent, Huntington is directly traceable to the use of coal as a fuel or as industrial raw material or to both. Even so, only about one-sixth of the coal produced in West Virginia is used in the state, the rest going to the Chesapeake Bay, New England, the Great Lakes, and other industrial areas.

It should be noted here that the major coal production areas and coal use areas of West Virginia are in valleys. This has been a major factor in increasing population densities in regions already settled and in creating new concentration areas such as Beckley, Bluefield and Williamson (Figure 1).

Several factors of great importance in the cost of production of coal make the location of mining activities in valleys almost without exception in this region. The fact that stream erosion has exposed coal seams on the valley walls makes mining expense less. Loading of coal by the force of gravity lessens this cost. Floodplains ease the cost and difficulty of rail and highway transportation. Bottom land furnishes favorable sites for coal cleaning, grading, and loading machinery.

Since there is considerable variation

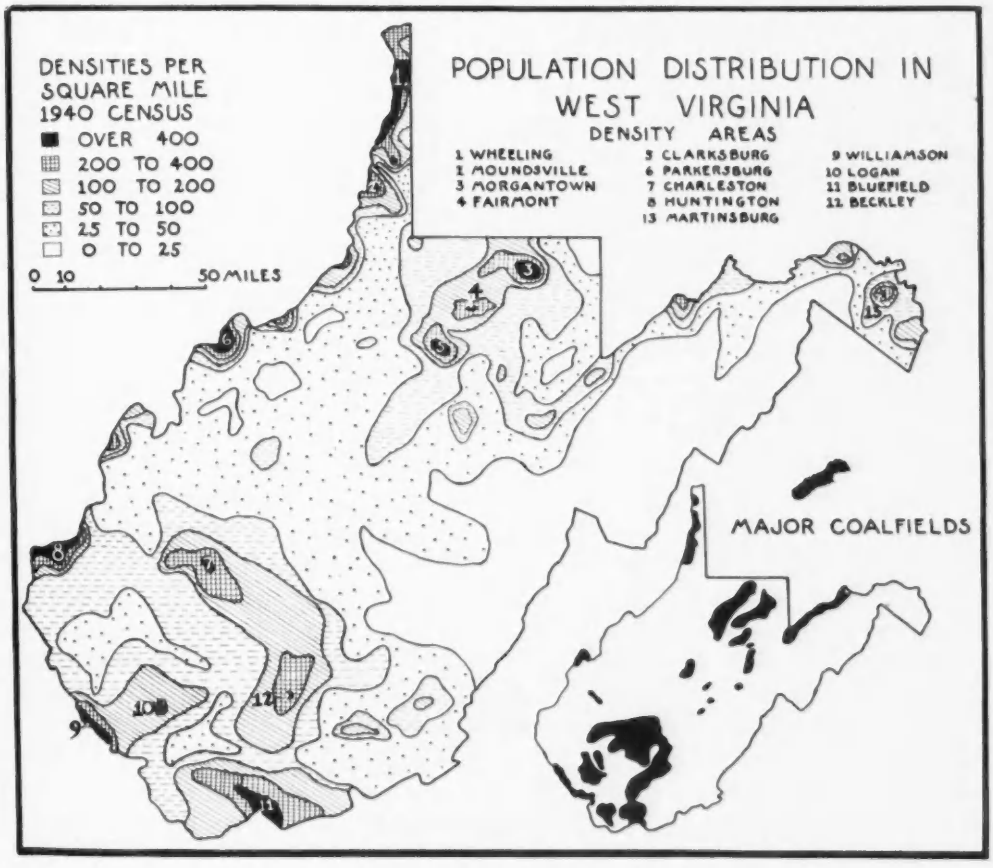

FIGURE 1.—Population Distribution in West Virginia.

in the reasons for the densities in each of the major areas of dense population, a brief summary of the major economic activities and natural factors contributing to such development will follow.

DENSITY AREAS

1. The Wheeling Area. The major activity of the Wheeling district is the manufacture of iron and steel products. Important factors contributing to the development of this industry are: an early start, the Panhandle Coalfield, cheap water transportation for raw materials, rail outlets for finished products, flat first and second river terrace land for factory sites, adequate water supply for domestic and industrial use, adequate labor supply, and easy access to major United States markets for iron and steel products. The city of Wheeling is the retail center for its densely populated suburban territory. The area has some miscellaneous industries including pottery, china, glass, and others.

2. The Moundsville Area. While close to Wheeling, Moundsville has considerable industrial independence of Wheeling. The population of the town in 1940 was 14,168, but the suburban population makes the total of the area much larger than that figure. Glass manufacturing is of great importance, based on nearby glacial outwash sand deposits and natural gas for fuel. Brick making and zinc smelting are other industries. Coal mining in nearby valley sides increases the total population of the area.

3. The Morgantown Area. Although in the same Monongahela Valley coal and transportation area as Fairmont and Clarksburg, Morgantown has some basic differences. It has the usual long established coal mining and glass manufacturing of this valley. It has had important growth traceable to chemical factories recently established there. The presence of West Virginia University adds to the population concentration at Morgantown.

4. The Fairmont Area. This area, also in the Monongahela Valley, has developed parallel to Clarksburg, for much the same reasons. Its specific industries consist of a large electrical supply factory and several glass factories, with coal mining in surrounding hillsides.

5. The Clarksburg Area. This is an area of older development in the Monongahela river valley. Coal mining, with the market at Pittsburgh, was among the earliest of the coal fields in the state to have extensive development. Valley outcropping of coal seams and river hauling encouraged early development of this resource. Intense folding of buried rock strata with consequent trapping of oil and gas explain the long-time importance of this area in oil and gas production and refining. Important remnants of this industry still remain. Some miscellaneous manufacturing consists of glass, marbles, zinc, and macaroni.

West Virginia's topography limits the agricultural possibilities of the state. Clarksburg is an important market center for one of the choice livestock and general farming regions of the state.

6. The Parkersburg Area. The outstanding factory in this area is a viscose plant producing basic materials for rayon and cellophane. Water supply, some timber, abundant cheap fuel, water and rail transportation, and adequate labor supply explain the location of this factory at Parkersburg. Other important industries both in city and suburban areas are oil refining, manufacture of oil, gas production, machinery, and mattresses.

7. The Charleston Area. While the area of over 400 per square mile popula-

tion density of this region is small, it is in the midst of a relatively new (since 1914) industrial region strung out up the Kanawha and Elk Rivers twenty to thirty miles above Charleston and some fifteen miles below the town. This surrounding area of 200–400 density is developing rapidly and is expected to reach the 400 level in the near future.

The outstanding factor in population concentration of this area is the chemical industry. South Charleston is recognized as one of the largest chemical centers in the United States. Some contributing factors are: coal by-products from nearby coke ovens, salt from long worked, as well as newly bored brine wells, easy access to Gulf Coast sulphur, an abundance of inexpensive natural gas plus coal for fuel, adequate supplies of industrial and domestic water, sufficient labor, and rail and water transportation.

Some other industries which mesh well with the chemical industry are also located in the valleys above and below Charleston. Synthetic rubber, glass, metallurgical, clay, and steel manufacturing concerns are in this list.

Charleston's position as capitol of the state is a further factor in the growing density of population in this area.

8. The Huntington Area. Huntington is the largest town in the state largely because more of its dense area of settlement is within corporation limits than in other towns. Even so, the area of dense population extends beyond corporation limits to an important degree.

Huntington is largely a town of wage earners, their families, and the people who provide the retail and social services furnished them. The list of industrial enterprises is fairly long and quite diversified. Such enterprises include nickel, railroad repair shops, the manufacture of dye, various iron and steel production, several glass concerns, and garment manufacturing.

These are favored by several important factors which include a large area of flat land on the inside of a bend in the Ohio River, adequate transportation by highway, rail, and water, both along the Ohio and its tributaries, and an abundant domestic and industrial water supply. One factor frequently missed in discussion of Huntington is the importance of natural gas as the main fuel basis of this town's industry. The supply of gas for Huntington is cheap and abundant. Huntington, industrially, is very close to being a "gas town."

9. The Williamson Area. Williamson is a retail and transportation center for a tremendous coal area which sits astride the West Virginia-Kentucky boundary. This region produces a large volume of coal which is famous on the market as "West Virginia Smokeless Coal." The mining is mainly along the valley sides of the Tug River and its tributaries where outcrops of coal were originally found.

10. The Logan Area. Logan is a transport and market town in an important coal mining area. Transportation in the Guyandotte River and tributary floodplains is important in this concentration of population. Logan has a large electrical power producing plant which utilizes coal as fuel.

11. The Bluefield Area. This town and surrounding area is similar to Williamson. Bluefield is situated in a valley dissecting the Appalachian plateau of the southern part of West Virginia. It is the merchandising and coal shipping center for a large coalfield which extends over the boundary to Kentucky and Virginia. In addition to producing a large tonnage, the coal of this field has a reputation for very high quality. Bluefield has both the Virginian and the Norfolk and Western

railroads. Large rail repair shops are maintained here employing several hundred people.

12. The Beckley Area. Beckley is the market and shipping center for an outstanding coal field in the upper reaches of the Kanawha and its tributaries. The Winding Gulf field is outstanding for the quantity and quality of coal produced.

13. The Martinsburg Area. This area's density of population is traceable to both industry and agriculture. Glass manufacturing is based on nearby deposits of glass sand, available fuel, and transportation to East coast markets. There are three large woolen mills in this area based largely on early start, skilled labor, available power, and access to markets. The manufacture of applesauce, cider, and vinegar reflects the importance of the surrounding apple growing district.

Livestock, as well as apples, indicate the suitability of the limestone valleys and ridges of this panhandle section to important agricultural production.

CONCLUSIONS AND FUTURE

One of the most significant trends in population growth in West Virginia has been the tremendous surge upward in population densities in the southern half of the state since 1900. This has resulted from the great and rapid development of coal production in southern West Virginia, and the rapid expansion of industry in Huntington and Charleston areas since 1914. The best prediction regarding future population distribution in the state is that densities will remain where they are, that the densities will grow in all areas, with greater expansion in areas of the state where the outstanding industries (chemical and alloy metal) are not so nearly up to the average national demand as is the case of steel, clay, china, and other older industries.

CEMENT PRODUCTION AND TRADE ON THE GREAT LAKES

Paul Cross Morrison

A DEVELOPMENT of geographic interest in the cement industry during the last twenty-five years, has been the location of many of the new plants on navigable waterways utilized both for cheap assembly of raw materials and for low cost distribution of cement in bulk cargo lots.

Nowhere is this trend better exemplified than along the shores of the Great Lakes, site of thirteen cement plants and scene of the development of the self-unloading bulk cement carrying boat. In addition to contributing materially to the industrial stature of the Great Lakes Region, these cement plants provide interesting illustrations of the varying importance of factors in the complex to be considered in locating for cement manufacture.

It is the purpose of this paper to first discuss in a general way conditions involved in the location of cement plants, and then to discuss more specifically the Great Lakes cement industry and trade. Statistics used and conditions described are of necessity largely those for the period just prior to the entrance of the United States into the present war.

Conditions Affecting Cement Plant Location

Cement is a cheap, heavy commodity, manufactured from bulky raw materials, and using considerable fuel. It can be produced profitably only on a fairly large scale basis. Consequently, major considerations affecting plant location are relative location to adequate supplies of raw materials and fuel, and to reasonably large markets.

Two common raw material combinations are used in the lake side cement plants, either a finely ground mixture of high calcium limestone with clay or shale, or one of high calcium limestone with blast furnace slag. Two plants use certain amounts of alkali waste, in place of limestone, mixed with clay or shale.

The ideal location for a cement plant would be one where supplies of raw materials and fuel were found in close proximity to each other and to a large market. This of course is not always possible.

When a high calcium limestone and clay or shale mixture is used, roughly 225 tons of limestone, 75 tons of clay or shale, 60 tons of coal, and five tons of gypsum are needed to produce 1,000 barrels of cement weighing 376 pounds each. Thus, nearly two tons of raw material and fuel must be assembled to produce each ton of cement.

In so far as raw materials are concerned, it can be concluded that the supply of limestone exerts the greatest influence on cement plant location. Not only are usable deposits of clay or shale present in most localities, but where not available one or the other of these materials can usually be shipped in from a distance more economically than can the much larger required weight of limestone.

Because much less coal than limestone is needed, and because developed coal deposits are less wide-spread than usable limestones and are thus adjacent

to fewer markets for cement, coal usually moves towards limestone. The problem is one of comparing relative mine prices, transportation costs, and heating capacities of available coals so as to obtain the greatest possible number of heat units per dollar spent.

Deposits of limestone are widely distributed, but not all are suitable for cement manufacture. If a limestone contains more than about 10 per cent magnesium carbonate it is not usable because finished cement must contain less than five per cent magnesia. Other limestones have improper ratios of alumina, silica, and iron oxide, or contain excessive impurities such as free silica, iron pyrite, or sulphur. Consequently it is desirable, though not absolutely necessary, that limestone used have a calcium carbonate content of over 90 per cent. When this is the case, little attention need be paid to impurities present, and mixing of the limestone with clay or shale to give the proper silica-alumina ratio for cement manufacture is facilitated.

Existence of a limestone deposit of suitable chemical and mineralogical characteristics near a supply of clay or shale and fuel does not alone constitute a suitable cement plant site. The deposit should be of such character as to permit cheap extraction by modern machine methods, and of such size as to supply the large needed amounts of stone for a number of years of plant operation. Especially important is the relative location of the deposit to transportation lines and to markets for the cement.

Early cement plants tended to locate adjacent to the supply of the lime bearing raw material, often far from the city market to which the finished cement was shipped by rail. Some of the earliest plants, those in the Lehigh Valley, used cement rock (argillaceous limestone) as a raw material. Naturally these plants located adjacent to the deposits of this rock for its composition

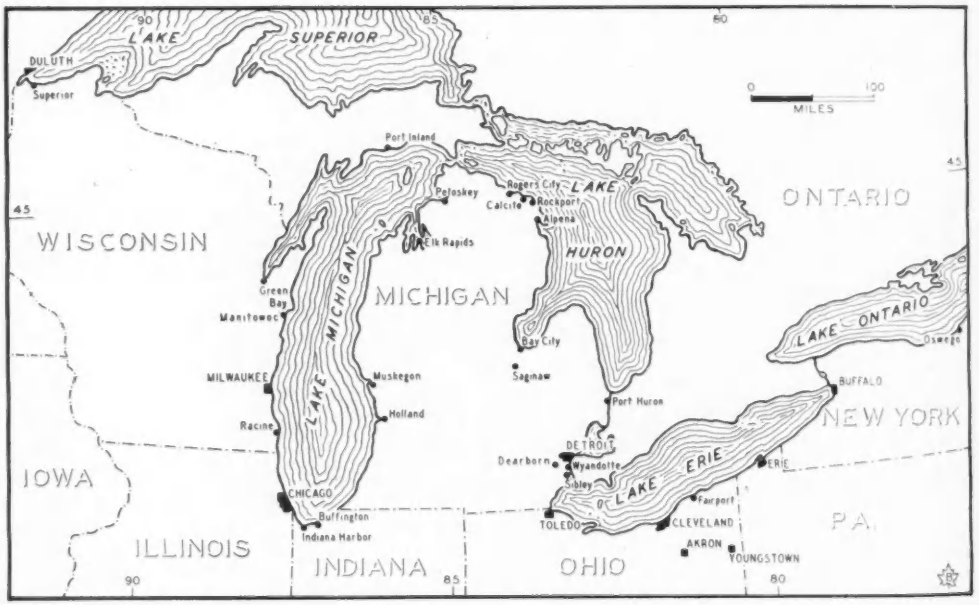

FIGURE 1.—Location of more important places connected with Great Lakes Cement Industry and Trade.

closely approached that of the required mixture for cement manufacture. Many other early plants used marl. These were consequently established beside the marl beds, this material being costly to ship because of its high moisture content.

The customary location of the earlier cement plants probably influenced many later established plants to locate adjacent to the limestone deposits used. Then too, it was argued that if limestone were shipped any distance, freight would be paid on a large amount of waste material, the carbon dioxide which is driven off in cement manufacture. This amounts to 40 or more per cent of the weight of the limestone used.

The common statement that cement plants are usually located near the source of raw material is, however, no longer entirely true. There has been a recent tendency for many plants to locate on the outskirts of large cities, sometimes many miles from the limestone deposit used. Especially has this been true where location upon a navigable waterway, giving cheap access to the distant supply of limestone, has been possible.

Used in buildings, streets, sidewalks, airports, and water and sewage systems, cement naturally finds an enormous and concentrated market in large urban centers. In addition, highways and railroads which radiate from the city not only demand cement, but give access to markets in surrounding towns and rural areas. If the cement plant is also located on a navigable waterway, the available market area is further extended by the possibility of cheap, bulk or package shipments by boat.

One factor of importance contributing to the tendency towards location in or near large cities has been the development of motor truck transportation. Cement from plants so located can be loaded directly into trucks for delivery to the job. This involves less handling than formerly, when the cement was delivered by rail from a cement plant at the limestone quarry, to warehouses in the city, and thence to consumers.

In addition, the city often provides a convenient meeting point for raw materials involved in cement manufacture. Coal may be obtainable as cheap or cheaper than at the limestone quarry. Clay or shale are usually available locally. While it is true that freight is being paid on waste amounting to 40 per cent or more of the weight of the limestone shipped to the city cement plant, still, freight is not being paid on the clay used, as it would be if finished cement were shipped from the quarry instead of limestone. Supposing clay or shale to be equally available either place, if limestone is moved from the quarry to the city instead of cement, about 120 pounds of limestone would be moved instead of 100 pounds of cement. Actually the differential in the cost of transporting a heavier weight of limestone or a lighter weight of cement is reduced and sometimes eliminated because (1) limestone needs no protection from weather, and (2) moves under a lower freight rate than does cement.

When blast furnace slag is used instead of clay or shale as a raw material, the amount of limestone needed is much less because part of the required lime is supplied by the slag. Lime content of slag varies, but assuming an average of about 35 per cent, roughtly 145 tons of high calcium limestone and 110 tons of slag would be needed for manufacture of 1,000 barrels of cement. If lime content of the slag be higher, amounts of limestone and slag required are more nearly the same. Because of this, and because blast furnaces are generally well located in reference to markets for cement, the limestone moves

to the slag. This slag thus becomes a very cheap raw material instead of a troublesome waste.

LOCATION OF LAKE-FRONT CEMENT PLANTS TO RAW MATERIALS

Location, name, and date of establishment of each of the thirteen cement plants situated on the Great Lakes can be determined from Table I and Figure 1. Four plants, those at Duluth, Buffington, Dearborn, and Buffalo (Federal Portland Cement Co.) use blast furnace slag and limestone as raw materials. The plant at Wyandotte uses alkali waste and shale; the plant at Detroit alkali waste, limestone and clay. The remaining seven plants use a mixture of limestone with clay or shale.

As might be expected, those plants using blast furnace slag or alkali waste are located adjacent to the iron and steel mills or the alkali plants which furnish them with their principal raw material (Figure 2). Being so situated they also automatically inherit the favorable location of the blast furnaces and alkali plants to important market areas.

All limestone used in lake-front cement plants comes from seven large quarries in Michigan, located at Port Inland, Calcite, Rockport, Alpena, Petoskey, and Sibley. The same is true of the lime constituents of the blast furnace slag and caustic sludge used, since the limestone used as furnace flux and in alkali manufacture also originates in the Michigan quarries.

FIGURE 2.—Plant of the Universal Atlas Portland Cement Company at Duluth, Minnesota. Limestone from Calcite, Michigan, and slag from the near-by blast furnaces is used in the manufacturing process. (Courtesy of the Universal Atlas Portland Cement Company.)

Only two cement plants, those at Alpena and Petoskey, are situated beside a limestone quarry, but because of the location of the Michigan quarries on the water front near the center of the Great Lakes system, and because of the very low cost of lake transportation, any cement plant located on the lakes is in effect placed near the source of limestone supply.

Quarrying and shipping of Michigan limestone have been discussed in two papers previously published in Eco-

NOMIC GEOGRAPHY (Vol. 18, No. 3, pp. 258–274, and Vol. 18, No. 4, pp. 413–427). Cheaply and efficiently produced by large scale mechanical methods from extensive lakeside deposits of high calcium limestone, and transported at low cost on the Great Lakes, Michigan limestone supplies cement plants fronting on the lakes with a cheap, high quality raw material. Indicative of the low cost of this stone is the F.O.B. price of 58 cents per short ton as reported by one cement plant. It is probable that in no case does the cost of limestone delivered to a cement plant dock greatly exceed one dollar per ton.

Although Michigan limestone had already been used indirectly for cement manufacture at what is now the Huron Portland Cement Company's Wyandotte plant, established in 1899 to utilize sludge from the adjacent alkali plant, the first direct use of Michigan limestone by a cement plant came with the opening of the Alpena Portland Cement Company plant at Alpena in 1901. Situated on the lake shore and on the limestone deposit used, this plant shipped by both rail and boat. It is said a considerable part of the boat shipments reached points outside of Michigan. The company encountered financial difficulties, however, and did not operate after 1907 (Figure 3).

Another early established water front plant was that of the Elk Rapids Portland Cement Company, later the Elk Cement and Lime Company. Built at Elk Rapids in 1901 as a marl-using plant, it was reconstructed about 1904 to use limestone obtained by rail from the deposit at Petoskey that is today used by the Petoskey Portland Cement Company. Little cement was made before 1905. During 1905 production amounted to about 9,500 tons. Annual production during subsequent years before abandonment of the plant in 1911,

FIGURE 3.—Suggestive of some medieval ruin, the crumbling walls of the Alpena Cement Company plant stand on the shore of Thunder Bay, two-thirds of a mile east of the Huron Portland Cement Company plant at Alpena, Michigan. This project failed despite favorable geographic conditions consisting of a lake front site and almost inexhaustable local supplies of essential raw materials.

ranged between 28,000 and 37,500 tons. Possibly 20 per cent of the product was shipped by water, practically all going to Milwaukee, although some went to Green Bay.

It is interesting that these early established water-front plants were failures. That this took place despite favorable geographic conditions in the case of the plant at Alpena, is attested by the success of a plant established later at that place.

In 1903, the Michigan Alkali Company began shipment of limestone from a quarry opened at Alpena in the same formation used by the Alpena Portland Cement Company. Since alkali manufacture requires clean, large-sized stone, the question of disposal of small stone soon arose. For a time this was wasted or was sold to the Alpena Portland Cement Company, but early in 1908 the Alpena plant of the Huron Portland Cement Company was opened to utilize this product. When placed in operation this cement plant was the largest in Michigan, a distinction it still holds, and it is today one of the largest in the nation (Figure 4).

The Universal Atlas Cement Company plant at Duluth used Michigan limestone from the start of operations in 1916, and was the first cement plant

outside of Michigan to use Michigan limestone. This company's plant at Buffington, though established in 1904, cannot be truly considered a water-front plant until June 9, 1927. On this date a commodious private harbor, built at a cost of some $2,000,000, was formally opened. Previously, limestone had been obtained by rail, chiefly from Indiana, while any cement shipped by water moved first to a dock at Indiana Harbor, about four miles from the plant. Though Michigan limestone and supplies of coal were regularly received from the date of opening, the shipment of finished cement via the new harbor did not occur until April 26, 1929.

As shown by Table I all other lake-front plants presently operating were established during the years 1921 to 1927 inclusive. All used Michigan limestone from the first. Considering this and the fact that 1924 to 1930 were record-breaking years in cement production, it is apparent that production of Michigan limestone for this purpose enjoyed a major growth during the decade 1920 to 1930. Also, it was during this decade that the Great Lakes cement industry achieved essentially its present-day character.

Statistics of Michigan limestone produced annually for utilization by cement mills are not regularly compiled. It is probable, however, that production for this purpose is usually exceeded only by that for flux and for alkali manufacture. In 1937, some 2,904,955 tons, or approximately 19 per cent of all Michigan limestone quarried, was for cement manufacture. Over 1,159,000 tons were shipped to lake-front cement plants outside of Michigan; the rest largely to lake-front plants within the state.

Except in the case of the Wyandotte plant, where receipts are by boat from Alpena, clay or shale used by the lake-front cement plans is obtained by rail from local or near-by sources. Most of the plants are about eight to twelve miles from their source of supply(Figure 5). One plant, that at Fairport, has obtained clay from a directly adjoining site. On the other extreme, shale used by the plant at Petoskey is moved a distance of about twenty-five miles.

Coal used is largely from Pennsylvania, Ohio, West Virginia, and Kentucky. This is delivered directly by rail to those plants located on Lake Erie. That destined for the other plants is moved at low rates from Lake Erie ports, especially Toledo, in self-

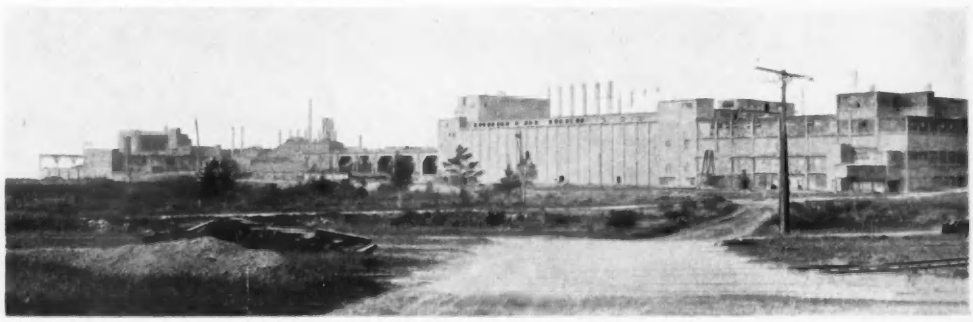

FIGURE 4.—Huron Portland Cement Company plant at Alpena, Michigan. Waterfront storage silos at which lake freighters load are at the left. Visible at the right near the top of the building, is one end of the 1300 foot long belt conveyor bridge over which small sized limestone is moved to the cement plant from the near-by quarry of the Michigan Alkali Company. (Courtesy of the Department of Geology and Geography, Michigan State College.)

unloaders or bulk freighters returning up lake.

RAW MATERIALS FROM WASTE AND INDUSTRIAL INTEGRATION

The extent to which the lake-front cement plants utilize as raw materials, what would otherwise be troublesome waste products of other industries is particularly significant. Not only is this true of those cement plants already mentioned as using blast-furnace slag and alkali waste, but to a considerable extent of most others as well.

Only one of the Michigan quarries supplying limestone to the Great Lakes cement industry was originally opened and now operates primarily for this purpose. This is the quarry at Petoskey, operated by the Petoskey Portland Cement Company (Figure 6). Quarries at Rockport, Calcite, and Port Inland were opened and now operate primarily to supply flux stone to the iron and steel industry; those at Alpena and Sibley to supply stone for alkali manufacture.

Open hearth flux stone commonly produced at the quarries is six to twelve inches, regular sized blast furnace flux stone, three to six inches, small sized blast furnace flux stone, one and one-half to three inches, and alkali stone, three and one-half to seven inches, in diameter. In producing these larger sizes of stone, production of quantities of smaller sized stone and "fines" is inevitable. In earlier days much of the smaller sized stone and especially the "fines" constituted a troublesome quarry by-product which was disposed of by wasting on near-by dumps. These grew to enormous size (Figure 7). The quarry at Calcite, for example, pumped several million tons of "fines" into Lake Huron, filling a sizeable area adjacent to the crushing plant.

More recently, as changing technology in cement manufacture made possible and desirable the use of finely ground limestone, and with the establishment of the lake-side cement plants, huge tonnages of the once-despised "fines" have been reclaimed from waste dumps and "lake storage" for sale to the cement plants. For this purpose, small size of stone is no objection, but an advantage, since the limestone must be pulverized before burning into cement (Figure 8). Ordinarily, when demand for flux and chemical stone is great, the quarries will produce a supply of "fines" and small sized stone equalling or exceeding that needed by the cement industry, but when, as in 1938, demand for the larger sizes of stone declines and by-product production of "fines" is consequently low, recovery is made from the waste dumps mentioned above.

The Peerless Portland Cement Company plant at Detroit provides still a different example of waste material utilization. Here certain amounts of the clay used have been obtained from overburden stripped from the limestone quarried at Sibley by the Solvay Process Company (Figure 9). Some also has been obtained from building excavations in Detroit.

A certain amount of integration with

FIGURE 5.—Shale from this quarry in the Antrim Formation at Paxton, about eight miles west of Alpena, Michigan, is used in the Alpena Plant of the Huron Portland Cement Company. (Courtesy of the Department of Geology and Geography, Michigan State College.)

FIGURE 6.—A part of the Petoskey Portland Cement Company quarry, opened in a terrace of glacial Lake Algonquin along the south shore of Little Traverse Bay, just west of Petoskey, Michigan. Some 3,500,000 tons of stone have been removed, and reserves are estimated sufficient for seventy-five years of operation. Thin bedding of the stone is in this case an advantage, since most of it is used in the cement plant. Electric quarry shovels were installed in 1939, shortly after the picture was taken. (Courtesy of the Department of Geology and Geography, Michigan State College.)

industries producing and transporting the by-products used as raw material by the lake-front cement plants is to be expected. The Universal Atlas Cement Company for example, is a subsidiary of the United States Steel Corporation. The cement plants at Buffington and Duluth use slag from near-by "Big Steel" blast furnaces. Limestone used is from the Michigan Limestone and Chemical Company quarry at Calcite, and is transported in boats of the Bradley Transportation Company and the Pittsburgh Steamship Company. All are subsidiaries of the United States Steel Corporation.

Slag used by the Federal Portland Cement Company at Buffalo comes from blast furnaces of the Bethlehem Steel Company, Inc., which previous to 1907, at least, held an interest in the cement plant.

The Ford Motor Company cement plant at Dearborn operates on slag from adjacent Ford-owned blast furnaces. Limestone used is purchased at Calcite from where it is commonly transported in Ford-owned boats.

The Huron Portland Cement Company, the Michigan Alkali Company, the Wyandotte Transportation Company, and the Huron Transportation Company are sister corporations. As already stated the cement plant at Wyandotte was established to dispose of waste from the near-by alkali plant; the cement plant at Alpena to utilize that stone too small for alkali manufacture produced at the adjacent alkali company quarry. The self-unloaders of the Wyandotte Transportation Company carry the limestone, coal, and shale used, while the cement carriers of the Huron Transportation Company move the cement produced.

The Standard Portland Cement Company plant at Fairport was established adjacent to a plant of the Diamond Alkali Company, of which it is a subsidiary, to make use of the smaller sizes of stone resulting from breakage in loading, transporting by boat, and unloading the quantities of large sized stone destined for the alkali plant. Since 1931 this limestone has come from the quarry of the Thunder Bay Quarries Company, Alpena, another subsidiary of the Diamond Alkali Company.

Of the cement plants having no corporate connection with limestone producing companies, at least two own considerable tracts of high calcium limestone land fronting on Lake Huron in

FIGURE 7.—A small part of the enormous excess screenings dump at the Port Inland, Michigan, plant of the Inland Lime and Stone Company. Machinery shown is recovering stone for road work. The cement industry has provided an important market for small sized stone, such as this, from Michigan quarries opened primarily to produce alkali and fluxing stone.

northern Michigan. These are the Aetna Portland Cement Company controling some 2,200 acres near Alpena and the Great Lakes Portland Cement Company with approximately 2,400 acres adjacent to Rogers City. These companies have to date found it advantageous to purchase needed limestone from operating quarries who have "fines" for disposal, but ownership of limestone reserves guarantees future supplies and reasonable prices.

LOCATION TO MARKET

Obviously those lake-side cement plants located at Buffalo, at Detroit, adjacent to Detroit at Dearborn and Wyandotte, and near Chicago at Buffington are well situated in reference to large consuming markets. Less apparent, however, is the extent to which other cement plants on the Great Lakes can be considered well located for marketing their product. Most of these plants are located at the break in transportation, on the edge of market areas served.

The plant at Manitowoc, for example, is the only one in Wisconsin. Centrally located on the eastern margin of the state, the town is a rail-lake terminal of considerable importance and an outlet for west-bound empty freight cars. Shipments can readily move via radiating railroads or highways to the northern peninsula of Michigan, all parts of Wisconsin, and points west.

In addition to the local city market, the plant at Duluth enjoys a favorable position in reference to consumers in a large area extending west from the head of the lakes into Montana.

Cement from the plant at Bay City supplies markets in Michigan, Wisconsin, Indiana, and Ohio in the order named. Formerly, about five per cent of the cement produced was shipped in bulk and none of this by boat. Of the package shipments, 60 per cent moved by truck, 25 per cent by boat, and 15 per cent by rail. The volume of the traffic and the distance cement is moved in this case (as much as 200 miles), well illustrates the importance of truck transportation to most lake-side cement plants. Shipments by water are no longer made because of the sale of the boats used to the government for war purposes.

The Fairport plant is advantageously placed to serve communities such as Cleveland, Youngstown, Akron, and Erie by rail or truck.

The Port Huron plant has a favorable location to an adjacent area in eastern

FIGURE 8.—Huge piles of cement stone (right) and fluxing stone (left) awaiting shipment from the Kelly Island Lime and Transport Company dock at Rockport, Michigan. The stone is recovered from the stock piles by means of belt conveyors working in concrete tunnels under the piles.

Michigan, but probably has the poorest competitive position of any of the plants considered. The plant was idle from 1932 to 1937. Since June, 1943, it has been used to manufacture lime, but can be shifted back to cement production on short notice.

The two remaining lake-front plants, those at Alpena and Petoskey, were located in reference to raw materials rather than to markets.

Theoretically, any lake-front cement plant, because of the economies of bulk transportation by water, is in effect placed in a position to compete in markets along the shores of all the lakes. Actually, only certain of the plants make extensive use of lake transportation in marketing their product. It should be stressed, however, that all make use of this medium of transportation either for assembly of raw materials or marketing, or both.

FIGURE 9.—Stripping operations at the limestone quarry of the Solvay Process Company, Sibley, Michigan. The thick overburden is a disadvantage in quarry operations, but some of this glacial clay has been used by the Peerless Portland Cement Company plant at Detroit. The limestone produced is generally a little high in magnesia for use in cement manufacturing.

DIRECTION OF LAKE CEMENT TRADE

In the following discussion the large amount of cement moved on car ferries is not considered because this is in a sense rail traffic, the car ferry being merely a bridge carrying loaded freight cars over a water barrier. The car ferry traffic is greatest on Lake Michigan.

Cement transported on the Lakes, other than by car ferry, largely originates at six ports. These are Alpena, Petoskey, Bay City, Manitowoc, Buffington, and Buffalo (Table II). All are sites of cement plants.

Alpena is by far the leading shipping point. From here more cement is annually dispatched by water than from all other Great Lake ports together. Petoskey is the second most important port of origin. That the cement plants at these two places, located as they are adjacent to limestone rather than markets, make large use of lake transportation is to be expected.

Logically, those cement plants on the lake shore intermediate in position between limestone and markets but not on the edge of large cities, might also make considerable use of the lakes as a medium for transporting their product. This is found to be true of the plants at Bay City and Manitowoc. On the other hand, if the records are complete, boat shipments from Port Huron were made only one year, and from Fairport only two years, during the period 1920 to 1940.

Of the lake-side cement plants located in or near large cities only two, one at Buffalo and one at Buffington, ship appreciable amounts by water. Shipments from Buffalo are almost entirely in the form of cement clinker. This comes from the Great Lakes Portland Cement Company, and is destined for Cleveland where this company established a packing and distributing plant in 1928 and added a grinding mill in 1930.

During most years, however, the amount of cement received at Buffalo

by water is greater than the amount of cement clinker shipped from there. Likewise more cement is commonly received at the port of Chicago than is shipped from near-by Buffington. Boat shipments of more than a few tons of cement annually from Detroit or Duluth are unusual, and are in any case greatly exceeded by receipts at these ports.

As shown by Table III, Milwaukee, Detroit, Cleveland, and Duluth are the four leading cement-receiving ports. Usually only a slightly lower tonnage is delivered at the port of Chicago. Other important receiving points are Buffalo, Toledo, Muskegon, Oswego, and Green Bay. Origin of receipts at certain of the above ports during 1938 can be determined from Table IV.

THE EARLY PERIOD OF LAKE CEMENT TRADE

Transportation of cement on the Great Lakes probably began soon after completion of the Erie Canal, for it was in the construction of this canal that natural cement, the product of the first efforts at cement-making in the United States was used. Previously, only lime mortars had been utilized to lay masonry in this country.

For many years, Buffalo was apparently by far the most important cement-shipping port on the lakes. The date of the first shipment is unknown, but during 1883, the first year of available continuous record, 212,960 barrels of cement and plaster were dispatched from this point. Peak shipments in 1907 totaled 804,619 tons (Table V).

Facts concerning the kind and origin of the cement shipped from Buffalo are obscure. Most of that shipped during earlier years was doubtless natural cement, with Portland cement becoming relatively more important later.

Not all cement shipped from Buffalo originated in New York state, however. During many years the reported shipments from Buffalo appear to have been greater than production in New York state, and this in spite of the fact that a major part of the state's annual output was certainly for home consumption (Table V).

This discrepancy is difficult to explain entirely. Some of the cement moved from Buffalo during some years at least was imported from Europe. Received at New York City, this material was delivered to Buffalo by canal, though on occasion it may have been brought by rail because of delays of canal traffic.

Some cement produced in Pennsylvania must also have reached Buffalo for lake shipment, though the writer found little evidence to support this

TABLE I

CEMENT PLANTS ON THE GREAT LAKES

Company	*Plant Location*	*Plant Established*	*Raw Materials*
Universal Atlas Cement Co.	Buffington, Ind.	1904	Limestone and slag
Universal Atlas Cement Co.	Duluth, Minn.	1916	Limestone and slag
Petoskey Portland Cement Co.	Petoskey, Mich.	1921	Limestone and shale
Medusa Portland Cement Co.	Manitowoc, Wisc.	1924	Limestone and clay
Huron Portland Cement Co.	Alpena, Mich.	1908	Limestone and shale
Huron Portland Cement Co.	Wyandotte, Mich.	1899	Caustic sludge and shale
Aetna Portland Cement Co.	Bay City, Mich.	1923	Limestone and clay
Peerless Cement Corp.	Port Huron, Mich.	1923	Limestone, clay, caustic sludge
Peerless Cement Corp.	Detroit, Mich.	1925	Limestone and clay
Ford Motor Co.	Dearborn, Mich.	1924	Limestone and slag
Standard Portland Cement Co.	Fairport, Ohio	1925	Limestone and clay
Great Lakes Portland Cement Co.	Buffalo, N. Y.	1927	Limestone and shale
Federal Portland Cement Co.	Buffalo, N. Y.	1927	Limestone and slag

TABLE II

LAKE SHIPMENTS OF CEMENT FROM MAIN PORTS OF ORIGIN, 1915–1940. (†)

(Short tons)

Year	*Manitowoc, Wisc.*	*Buffington, Ind.*	*Petoskey Cement Harbor, Mich.*	*Alpena, Mich.*	*Saginaw River, Mich., at Essexville*	*Buffalo, N. Y.*	*Total from Main Ports*
1915	.....	.....	.....	182000(B)	.....	8276	190276
1916	.....	.....	.....	110456(B)	.....	79210	189666
1917	.....	.....	.....	166130	.....	480	166610
1918	.....	.....	.....	159800	.....	76	159876
1919	.....	.....	.....	149140	.....	.....	149140
1920	.....	.....	.....	162563	.....	.....	162563
1921	.....	.....	14700	176984	.....	.....	191684
1922	.....	.....	35432	182014	.....	2060	219506
1923	.....	.....	39790	176985	.....	.....	216775
1924	325	.....	52942	255098	.....	938	309303
1925	3846	.....	38023	420553	.....	651	463073
1926	7456	.....	53599	535118*	.....	.....	596173
1927	66672	.....	57803	558117*	15233	.....	697825
1928	73890	(A)	51447	621672*	56315	1860	805184
1929	69274	11787	100887	622340*	55564	41030	900882
1930	58079	8360	111437	600806*	56384	57130(x)	892196
1931	41014	38020	89260	403843*	62019	63002(x)	697158
1932	26485	28585	25640	289042*	34120	58906(x)	462778
1933	10643	13585	61037	219529*	30572	25593(x)	360959
1934	28039	17581	62018	248976*	49851	11911(x)	418376
1935	28521	34093	82018	253050*	25748	5400(x)	428830
1936	37512	57856	98725	508070*	80885	16750(x)	799798
1937	35341	46485	124007	495407*	64857	22806(x)	788903
1938	35989	29359	110879	417485*	45224	25171(x)	664107
1939	48285	58910	128883	585149*	22754	30916(x)	874897
1940	46942	55330	144243	534623*	27039	49209(x)	857386

(†)Compiled from *Annual Reports of the Chief of Engineers*, U. S. Army. These reports contain records of cement shipments from other points on the Great Lakes where cement plants are located, only as follows—Port Huron, 28860 tons in 1929; Fairport, 6707 tons in 1932 and 10650 tons in 1933; Detroit, 5469 tons in 1930 and 9437 tons in 1935. There are also reports of very small shipments from Detroit during several other years.

*Reported as limestone products, but can be considered to be cement.

(A)There is record of shipments of 50124 tons from Indiana Harbor in 1920. Possibly shipments of Buffington cement were made from Indiana Harbor during other years but were not reported separate from miscellaneous freight.

(B)In addition, 65000 tons of clinker were shipped in 1915 and 6283 tons in 1916.

(x)Largely cement clinker destined for Cleveland. For receipts of this clinker at Cleveland see Table III.

supposition. Most of the Pennsylvania production was in the eastern part of the state, particularly in the Lehigh district, a long rail haul from Buffalo.

It should be noted also (Table V) that annual shipments reported from Buffalo before 1905 were of plaster and cement together. Possibly some lime was included, it being a cementing material. Although shipments after 1905 were reported only as cement these may have also included certain amounts of plaster. New York has produced large amounts of plaster from gypsum mines located within fifty miles or so of Buffalo, but there is apparently no record of how much of this material was shipped from Buffalo during the years in question.

The cement embarked at Buffalo reached widely separated points on the lakes. It was shipped in bags or barrels. Considerable amounts were doubtless used in making the extensive harbor improvements of that time. Although early records of cement shipments or receipts at lake ports other than Buffalo, Chicago, and Duluth-Superior are very incomplete or entirely lacking, those available indicate that Chicago was usually the most important receiving port. Receipts at Duluth-Superior were commonly second in amount. After reaching a peak in 1900, receipts at Chicago declined. About 1908, Duluth-Superior became the most important receiving port, a position apparently

retained for at least the next decade (Tables III and V).

Lake shipments of cement from Buffalo were first exceeded by those from Alpena in 1911. Alpena has ever since been the leading port of origin. Shipments from Alpena from 1901 to 1907 inclusive were from the Alpena Portland Cement Company; those after 1907 from the Huron Portland Cement Company (Tables II and V).

LAKE TRANSPORTATION AND TERMINAL FACILITIES

The Huron Portland Cement Company, Alpena, was the first to make large shipments of cement in bulk on the lakes, the first to develop and use specially designed self-unloading boats for carrying bulk cement, and the first to establish and operate a system of storage silos and bagging plants at important lake-side delivery points.

The first bulk shipment of cement by boat from Alpena was made October 5, 1916, on the "Samuel Mitchell." Previously cement had been packaged in bags or barrels before shipment, and loading a boat required the services of half a hundred men several days. Today, mechanical loading of bulk cement permits dispatch of a vessel within a few hours.

The "Samuel Mitchell" was the first vessel to be equipped with machinery for unloading cement. Built in 1892 at the Globe Iron Works, Toledo, this boat was purchased by the Huron Transportation Company and converted in 1916 into a self-unloader, having a

TABLE III

RECEIPTS OF CEMENT AT SELECTED GREAT LAKE PORTS, 1915–1940. (†)

(Short Tons)

Year	Duluth and Superior, Minn. and Wisc.	Green Bay Harbor, Wisc.	Milwaukee Wisc.	Port of Chicago, Ill.	Muskegon, Mich.	Saginaw River, Mich., at Carrollton	Port of Detroit, Mich.	Toledo, Ohio	Cleveland, Ohio		Buffalo, N. Y.	Oswego, N. Y.
									Cement	Clinker		
1915	93970	4940	41422	480	.....	.....	.....	.....	16440	.....	.....	.....
1916	81783	2515	45244	.....	.....	.....	.....	.....	10200	.....	.....	.....
1917	40740	1936	26226	.....	.....	.....	.....	.....	19355	.....	.....	.....
1918	50811	1162	25647	.....	.....	.....	.....	.....	26000	.....	.....	.....
1919	55633	390	29165	.....	.....	.....	(B)	.....	16820	.....	.....	.....
1920	54150	14446	37350	.....	1340	.....	53910	1754	39243	.....	.....	.....
1921	58844	3110	43252	.....	.....	.....	?	.....	13400	.....	.....	.....
1922	45580	12350	43586	.....	.....	.....	85656	.....	19457	.....	.....	.....
1923	32490	1834	55766	.....	.....	.....	115934	.....	17530	.....	.....	.....
1924	37019	.....	68442	.....	.....	.....	160852	.....	28772	.....	.....	.....
1925	62800	.....	65492	.....	.....	.....	210850	.....	64837	.....	.....	.....
1926	65630	.....	74571	3584	.....	.....	366261(x)	.....	62300	.....	.....	.....
1927	85829	1750	119394	41957	3667	.....	324290(x)	.....	71000	.....	.....	.....
1928	78840	2138	194510	36360	.....	.....	.....	.....	56358	.....	.....	.....
1929	105553	.....	222873	48680	.....	.....	28860	.....	.....	.....	714	.....
1930	137256	.....	196294	53747	.....	.....	31781	33221	44078	.....	44118	.....
1931	114728	.....	155149	45190	.....	.....	44018	41980	31930	62048	37890	.....
1932	91339	380	95632	11021	1316	.....	58203	9824	42805	58780	64257	11961
1933	35027	3461	52311	38259	.....	18102	59863	12186	15378	28521	49637	28685
1934	74550	9579	66235	49807	10401	.....	31691	17971	18642	11911	26170	32271
1935	57068	17677	84753	45250	9449	33077	116882	17821	13204	5400	19614	7600
1936	172077	28389	128913	65193	30883	66466	122833	29770	44558	16415	.....	12680
1937	(A)	24240	127690	61346	33639	61627	111116	38869	27015	22806	48302	20176
1938	73702	31357	87166	69058	41030	38829	113863	34622	68911(x)	24986	47742(x)	14556
1939	(A)	57190	151700	67906	35558	65826	145627	43145	100937(x)	30655	50423(x)	25439(x)
1940	(A)	33623	129477	83005	56486	41924	130181	59860	78404(x)	49209	59992(x)	32863(x)

(†)Compiled from *Annual Reports of the Chief of Engineers*, U. S. Army. Other receiving ports less important than the above, but worthy of mention, are Holland and Menominee, Michigan, and Racine, Wisconsin.

(A)Limestone and limestone products or cement not reported separately.

(B)There is no record of commerce at Port of Detroit before 1920.

(x)Reported as limestone products, but can be considered to be cement.

carrying capacity of about 14,000 barrels of cement. In July, 1942, she was requisitioned by the War Shipping Administration, stripped to the spar deck, taken down the Mississippi, and put into ocean service in the Latin-American trade.

As a result of experience gained with the "Mitchell," the Huron Transportation Company in 1923 launched the first vessel to be specially built and equipped for handling bulk cement exclusively. This boat, the "John W. Boardman," was much larger than the "Mitchell." A vessel of 3,815 gross tons, 400-foot length, 55-foot beam, 20-foot draft loaded, and carrying capacity of 36,000 barrels, it was built at a cost of approximately one million dollars.

The third self-unloader of the Huron Transportation Company fleet, the "Stanford T. Crapo," was also built for use exclusively in the cement trade. Launched in 1927, it has a cargo capacity of 40,000 barrels.

These self-unloading boats are equipped with specially constructed holds which feed the cement to longitudinal screw conveyors located beneath the cargo. These in turn discharge to bucket elevators from which the cement is carried ashore on movable screw conveyors. Two Fuller-Kinyon pumps, which force the cement ashore like a fluid through pipes, were added to the "Crapo" in 1930. This vessel is also equipped with bagging machinery. It thus has great adaptability for discharging cargo, and has on occasion been used as a temporary floating warehouse and bagging plant where shore facilities for handling cement were not available.

Excepting two Canadian boats which carry no cargo to or from United States lake ports, other self-unloading cement carriers on the Great Lakes are the "J. B. John," operated by the Petoskey Portland Cement Company, and the "Daniel McCool," operated by the Cement Transit Company. The latter carries cement for the Manitowoc Portland Cement Company and is a subsidiary of that company.

The "John" was converted to a self-unloader in 1929, having previously been used to carry bagged cement. It has a cargo capacity of about 13,000 barrels. The "McCool" was constructed to be a cement carrier in 1926 and has a 4,000-barrel cargo capacity. Both vessels are equipped with screw conveyors below the cargo which discharge to Fuller-Kinyon pumps. The "McCool" was the first cement carrier to use the Fuller-Kinyon pumping system for loading and unloading. It is also equipped with bagging machinery.

Unloading rates vary from about 400 barrels per hour for the "McCool" to as high as 2,000 barrels per hour for the "Crapo." Loading rates vary even more, the hourly rate being in the neighborhood of 600 barrels per hour at Manitowoc, 1,400 barrels at Petoskey, and 5,000 to 6,000 barrels at Alpena. Loading at Manitowoc and Petoskey is by Fuller-Kinyon pump systems. At Alpena, screw conveyors under the storage silos feed two Fuller-Kinyon pumps which move the cement to seven shuttle screw conveyors. These in turn are run out over the boats, discharging into the hold through flexible spouts.

The larger part of the cement moved on the Great Lakes is carried by the above-mentioned self-unloaders. Cement which formerly moved by water from Bay City, was usually bagged and was carried by boats of the Midwest Transportation Company, a subsidiary of the Aetna Cement Company.

Water shipments from Buffington have been largely in bulk, being transported in a barge built especially for

this purpose. The Peerless Cement Corporation owned and operated a fleet of two barges and one tug from 1928 to 1930 to transport bulk cement from the plant at Port Huron to Detroit. The barges were unloaded by pumping, using Fuller-Kinyon pumps. Both the barges and the tug have been sold and the company now makes no water shipments.

Having proved their worth on the Great Lakes, self-unloading cement carriers and barges have since been put into service both on the Mississippi waterway and in coastal waters.

Although cheap transportation of large volumes of bulk cement on the Great Lakes was facilitated by the development of the above-discussed specially equipped self-unloading freighters, successful utilization of this mode of transportation was made possible only by the establishment of new terminal facilities in the form of storage silos and bagging plants at important receiving ports. Delivered ashore by the self-unloaders, the cement is carried to the top of the storage silos by systems of bucket conveyors or by being pumped through pipes by Fuller-Kinyon pumps. From the storage silos and adjoining pack plants, the product can be quickly trucked or moved by rail to the consumer's job, in bulk or bags, as desired.

Because of economies gained through the bulk transportation of cement and the efficient service rendered consumers from strategically located pack plants, this mode of distribution has become important, not only on the Great Lakes, but elsewhere. Especially has this been true in coastal waters and along navigable inland waterways such as the Mississippi, Ohio, and Hudson rivers.

Located on the lake shore beside a

TABLE IV

ORIGIN OF CEMENT RECEIVED AT CERTAIN GREAT LAKES PORTS DURING 1938*

(Short tons)

Receiving Ports	*Buffalo, N. Y.*	*Saginaw River, Mich. at Essexville*	*Alpena Mich.*	*Manitowoc Wisc.*	*Petoskey Mich.*	*Buffington, Ind.*	*Total Receipts*	*Receipts not accounted for*
Buffalo, N. Y.	.....	.....	47742	.....	.....	.....	47742	none
Cleveland, Ohio	24986(†)	.....	68911	.....	.....	.....	93897	none
Toledo, Ohio	.....	.....	34622	.....	.....	.....	34622	none
Detroit, (Port of), Mich.	.....	5730	62963	.....	45170	.....	113863	none
Duluth-Superior, Minn. and Wisc.	185	.....	73517	.....	.....	.....	73702	none
Milwaukee, Wisc.	.....	.....	30134	15936	15117	25979	87166	none
Chicago, (Port of), Ill.	.....	.....	.....	18466	50592	.....	69058	none
Total accounted for	25171	5730	317889	34402	110879	25979	520050	....
Total shipments	25171	45224	417485	35989	110879	29359	664107	....
Tons not accounted for	none	39494(A)	99596(B)	1587(C)	none	3380(D)	144057	....

*Compiled from *Great Lakes Port Series (Revised 1939)*, Corps of Engineers, U. S. Army, Washington 1939 and 1940 Statistics in some cases were reported under heading, "Limestone Products," but this can be considered as cement.

(†)Cement clinker.

(A)Receipt at Racine, Wisconsin, amounted to 11602 tons, and at Green Bay, Wisconsin, to 31351 tons. Much of this cement probably came from Saginaw River, Michigan, at Essexville. Some cement received at Green Bay probably also came from Alpena, Michigan, and Buffington, Indiana.

(B)Receipts at Oswego, New York, of 14566 tons, at Saginaw River, Michigan, at Carrollton of 38829 tons, and at Muskegon, Michigan, of 41030 tons, totaled 94425 tons. Most of this probably came from Alpena, Michigan, with the possible exception of a small amount received at Muskegon. Some cement from Alpena no doubt also reached Green Bay, Wisconsin. The cement plant at Alpena maintains storage silos and pack plants at all of these points, as well as at places indicated in the table above.

(C)The cement plant at Manitowoc, Wisconsin, ordinarily ships cement to Holland, Michigan, by water, but no receipts were reported at that port during 1938.

(D)The cement plant at Buffington, Indiana, maintains packing plants at Muskegon, Michigan, and Green Bay, Wisconsin, as well as at Milwaukee, Wisconsin. Cement not shipped to Milwaukee probably went to either, or both, Muskegon and Green Bay.

TABLE V

CEMENT

SELECTED STATISTICS OF PRODUCTION AND TRADE, 1882–1915

Year	New York Portland Cement Production (Barrels)	United States Portland Cement Production (Barrels)	New York Natural Cement Production (Barrels)	United States Natural Cement Production (Barrels)	United States Cement Imports (Barrels)	Shipments from Buffalo, N. Y. (Tons)	Shipments from Alpena, Mich. (Tons)	Receipts at Duluth-Superior, Minn. and Wisc. (Tons)	Receipts at Chicago, Ill. (Tons)
1882	.....	85000	.....	3165000	370406	(A)	.....	.....	.....
1883	.....	90000	.....	4100000	456418	212960*	.....	.....	.....
1884	.....	100000	.....	3900000	585768	203600*	.....	.....	.....
1885	.....	150000	.....	4000000	554396	268690*	.....	.....	.....
1886	.....	150000	.....	4350000	915255	378940*	.....	.....	.....
1887	.....	250000	.....	6692744	1514095	413890*	.....	.....	.....
1888	.....	250000	.....	6253295	1835504	370790*	.....	(C)	.....
1889	.....	300000	.....	6531876	1740356	409400*	.....	13060	(D)
1890	65000	335500°	3776756	7441116	1940186	91156	.....	18131	21151
1891	87000	454813	3931306	7767979	2988313	81578	.....	48424	26441
1892	124000	547440	3780687	8211181	2440654	88936	.....	15961	82773
1893	137096	590652	3597758	7411815	2674149	65156	.....	7787	61557
1894	117275	798757	3446330	7563488	2638107	71413	.....	34388	46475
1895	159320	990324	3939727	7741077	2997395	78766	.....	30917	68534
1896	260787	1543023	4181918	7970450	2989597	94466	.....	32004	?
1897	394398	2677775	4259186	8311688	2090924	115407	.....	30321	123036
1898	554358	3692284	4157917	8418924	1152861	212089	.....	46184	154980
1899	472386	5652266	4689167	9868179	2108388†	214124	.....	67405	150488
1900	465382	8482020	3409085	8383519	2386683	472870	.....	75989	235163
1901	617228	12711225	2234131	7084823	939330	566084	(B)	34304	132148
1902	1156807	17230644	3577340	8044305	1963023	613230	3549	36692	147602
1903	1602946	22342973	2417137	7030271	2251969	566385	9106	40212	115258
1904	1377302	26505881	1881630	4866331	968409	481798	19500	33477	55683
1905	2117822	35246812	2257698	4473049	896845	?	?	?	?
1906	2423374	46463424	1691565	4055797	2273493	766005	31545	341896*	67444
1907	2108450	48785390	1137279	2887700	2033438	804619	23986	168148*	59315
1908	1988874	51072612	623588	1686862	842121	224548	19836	231377*	16538
1909	2061019	64991431	549364	1537638	443888	185332	55728	108013	16430
1910	3364255	76549951	292760	1139239	306863	550147	102087	143810	43488
1911	3416400	78528637	274973	926091	164670	166230	110363	120423	4586
1912	4495842	82438096	287693	821231	68503	111972	187411	95768	6419
1913	5146782	92097131	193975	744658	85470	66937	116044	81038	4213
1914	5667728	88230170	232076	751285	120906	31096	170656	75619	1122
1915	5219460	85914907	223564	750863	42218	8276	182000	93970	480

Sources: Production of Portland cement and natural cement in the United States and imports into the United States compiled from *Minerals Yearbook*, Bur. Mines, U. S. Dept. Interior; production of Portland cement and natural cement in New York taken from Mineral Resources of the State of New York, *New York State Museum Bull.* No. 223–224, July–August 1919, p. 46; shipments and receipts at lake ports compiled from *Annual Report of the Chief of Engineers*, U. S. Army.

°Figures for 1890 and previous years are estimates believed to be substantially correct.

†Figures after 1899 represent "Imports for Consumption"; those before 1899 "Total Imports."

*Barrels.

(A) Shipments before 1905 were reported as "cement and plaster."

(B) Shipments during the years 1902 to 1906 inclusive and 1910 to 1912 inclusive were reported as "cement and lime." In addition to cement, cement clinker shipped amounted to 47382 tons in 1913; 55000 in 1914; 65000 in 1915; and 62830 in 1916.

(C) Receipts before 1905 were reported as "cement and lime" except during years 1892, 1893, 1894, and 1901.

(D) Receipts before 1901 were reported as "cement and plaster" except during years 1890 and 1891. Receipts at South Chicago not included.

limestone quarry, but removed from large markets, the Alpena plant of the Huron Portland Cement Company doubtless owes much of its present size to leadership in developing the above-discussed methods of distribution. Storage silos and pack plants are maintained at Oswego, Buffalo, Cleveland, Toledo, Detroit, Saginaw, Duluth, Green Bay, Milwaukee, and Muskegon. The Petoskey Portland Cement Company has facilities of this type at Detroit, Milwaukee, and Chicago; the Universal Atlas Cement Company at Milwaukee, Muskegon, and Green Bay; the Manitowoc Portland Cement Company at Milwaukee, Chicago, and Holland. The Aetna Portland Cement

Company formerly maintained warehouses for storing packaged cement at Green Bay and Racine, but since purchase of their boats by the government, shipments to Wisconsin consumers have been direct by rail.

Storage capacities of these branches range upwards to 175,000 barrels, with the most common figure being from 50,000 to 75,000 barrels. These capacities are, however, not as large as might seem necessary in view of the stoppage of lake traffic by freezing for a four- to five-month period. This is because there is also normally a curtailment of consumer demand for cement during the winter months, as a result of the seasonal character of construction and road-building activities.

CONCLUSION

Situated in the heart of a rich continent, the Great Lakes and their connecting waterways form a single navigation unit with a long east-west extent paralleling the direction of major trade movement. This greatest of inland waterways has been likened to a huge magnet, drawing to it population, industry, and trade. These beget more industry and population—consumers of cement.

High quality limestone, the most important raw material for cement manufacture, was available at low cost in bulk cargo lots via lake boat from northern Michigan. Fuel was available from the Appalachian coal fields. Markets, limestone, and fuel were available—all the important requisites for successful cement manufacture.

Some of the cement plants attracted to the lake shores have been established on the edge of large lake-side cities, in several cases adjacent to blast furnaces or alkali plants furnishing a waste product used in the cement mixture. Other plants have been established at shore transhipment points, located so as to command markets of interior areas. Only two of the plants have been located beside limestone quarries, both distant from the larger urban markets.

These later two plants especially, but certain of the others as well, have made large use of lake transportation in marketing their product. This trade has been facilitated, if not made possible, through the development of boats especially designed to carry and discharge bulk cement cargoes, and the establishment of a system of storage silos and pack plants at leading lake terminals. Though not all lake-side cement plants make use of lake transportation for marketing, all use this medium for the assembly of raw materials and coal.

Directly or indirectly the Great Lakes have made possible, yes demanded, the establishment of the cement industry along their shores. The future of this industry is tied up with that of the Great Lakes Region; as the region prospers so the cement industry will prosper.

DAIRYING IN THE SOUTH

Halene Hatcher

DURING the past few years, portions of the agrarian South have made marked changes in agricultural practices, as is indicated by the many communities that have renounced one-crop systems and have affirmed allegiance to the dairy cow. This, no doubt, is one step toward the attainment of a greater degree of agricultural security and economic stability.

Southerners are beginning to realize, as never before, the necessity of changing their farming procedures from "one-armed production," as Clarence Poe very aptly terms the antiquated and devastating one-crop system, so long the curse of the South, to the "two-armed production," that of animals in association with plants. The agricultural leaders of the South today are aware of the fact that no mere increase of crops will give the desired agricultural prosperity. This will come only to the degree and extent to which the proper balance of the production of plants and of animals is maintained.

Therefore, one avenue of approach to a brighter future for the South is through the further development of the dairying industry.

Distribution and Present Trends

That commercial dairy farming is significant in portions of the South is manifested by a study of the areal distribution and present trends of this activity. Thus, an examination of the map (Figure 1) showing the number of cows and calves kept for milk is of value. From the study of this map it is evident that there is a widespread distribution of dairy cattle throughout the South and that there are points of marked concentration. Most notable among these are parts of the Coastal Plain and the Piedmont of Maryland and Virginia, the self-sufficing areas of the Appalachian Highlands and the Ozark-Ouachita region, the Interior Low Plateaus of Kentucky and Tennessee, east central Mississippi, the Central Lowlands of Oklahoma, a great part of east Texas, and many widely separated areas which are near the growing centers of population. However, it must be kept in mind that in comparing one area with another the density of dairy cows is not always a true indication of the amount of milk produced because of variations in the milk production per cow.

So, for a more definite concept of actual production, turn to the map (Figure 2) showing the distribution of milk. This map reveals that Maryland, north-central Kentucky, central Tennessee, east central Mississippi, central Oklahoma, parts of east Texas, and areas adjacent to cities have an actual production of milk greater than that suggested by the map showing the density of dairy cows; and southwest Texas and some portions of the Coastal Plain have a lower production than is indicated by the distribution of the cows alone. Figure 2 thus qualifies Figure 1 by revealing more significant contrasts between areas.

That dairy cows are increasing in number at a more rapid rate in the South than in any other major portion

of the United States is indicated by a recent report by Finner and Mighell (Finner, W. F. and Mighell, Ronald L., "Trends in Dairying by Major Type-of-Farming Regions," *United States Dept. of Ag., Tech. Bul.*, 751, January, 1941). According to this investigation, which covers the period from January 1, 1928, to January 1, 1939, the per cent of increase in the number of dairy cows in the Cotton Belt was 24.4, while the average for the United States was 12.9. Furthermore, the self-sufficing sections (the southern Appalachian highlands and the Ozark-Ouachita area) closely followed the leader with an increase of 21.9 per cent.

Although these figures are significant in indicating the recent expansion of dairying, Finner holds that as some regions with small increase in number of cows rank high in the percentage rate of increase because of the small number of cows in the area in the base year, an index of even greater value is the absolute increase in the number of milk cows in each region and the percentage that this is of the total increase in the United States. According to this measure, the Cotton Belt again takes lead with a total increase of 708,000 milk cows, or 24.9 per cent of the total increase in the United States, while that for the Dairy Belt is 681,000 head or 23.9 per cent.

Three sections of the South which have had especially large increases in the number of milk cows are northeastern Texas, south central Tennessee, and east central Mississippi. It is in these areas, according to Finner, that during the period from 1928 to 1939 an increase of 96,000 head occurred. This accounts for approximately 14 of the 24.4 per cent increase in the entire Cotton Belt during the period.

For the South in general, and especially for the three areas of vigorous expansion, the increase in density of dairy cows has been accompanied by a corresponding increase in the produc-

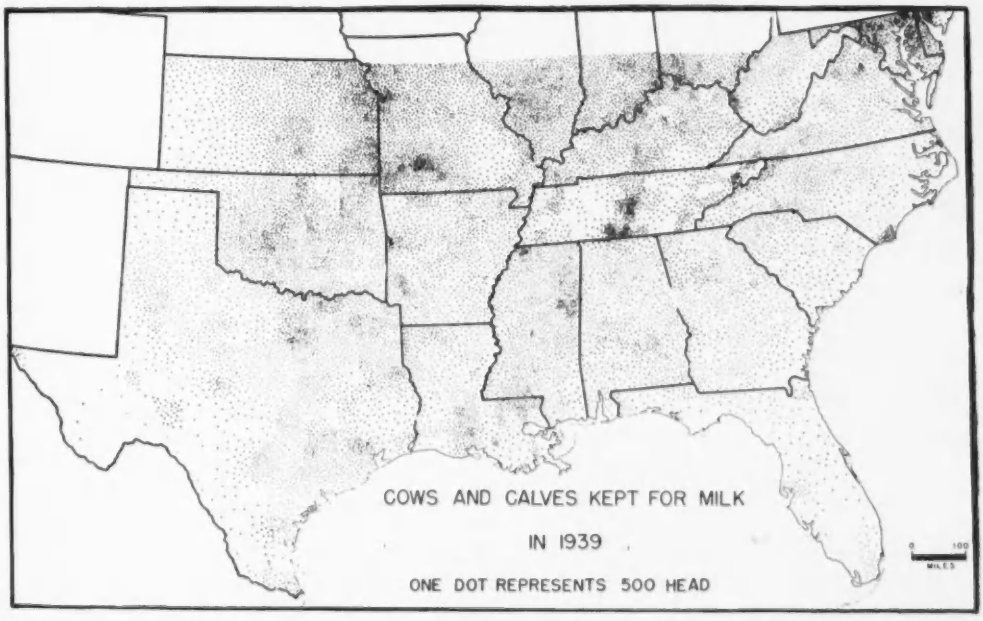

FIGURE 1.—Throughout the South there is a widespread distribution of cows and calves kept for milk. Taken alone, however, the density of dairy cows is not an adequate index to the amount of milk produced because of variations in the milk production per cow. (For comparative study, this map and the others which follow include areas beyond the boundaries of the South.)

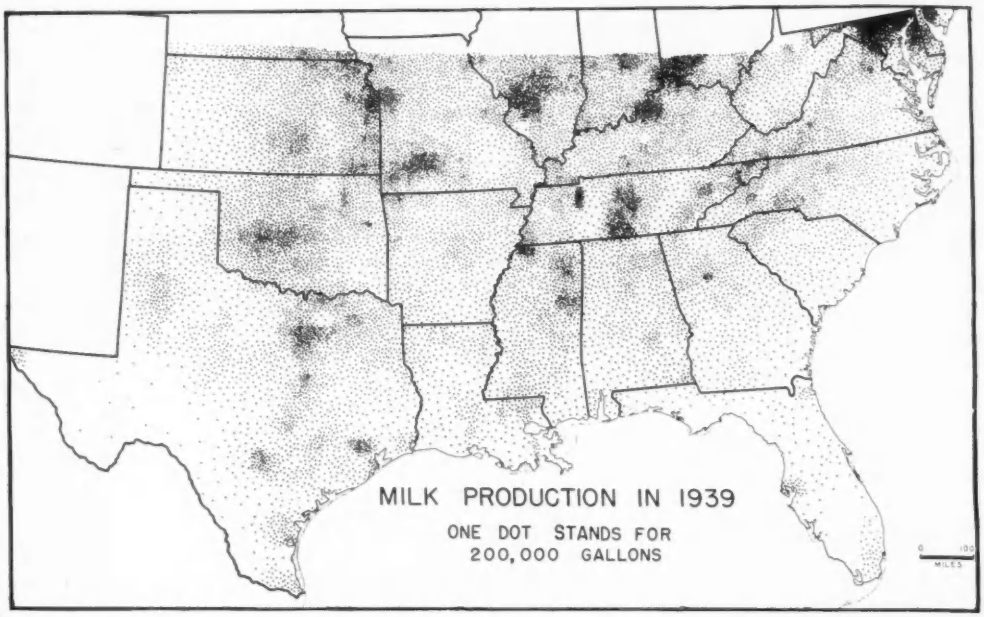

FIGURE 2.—This map of the production of milk reveals significant contrasts in various portions of the South. East Texas, central Oklahoma, northeast Mississippi, central Tennessee, the Blue Grass region of Kentucky, and northeast Virginia and Maryland rank high in the production of milk.

tion of butter, cheese, evaporated milk, and various products of the milk-processing plants. For example, from 1928 to 1938, the increase in the production of butter in factories in the Cotton Belt was 91 per cent, while that of the United States for the same time was 20 per cent.

However, as the increased output of these products has made a comparatively small appearance in the large receiving centers of the Midwest and Northeast, and as this increase has not been as marked as that of the milk production, it is evident that the low milk consumption of the South is also beginning its long delayed climb toward a more satisfactory level, and that the manufactured products are going to widely scattered markets to take care of the recent growth in population of the southern cities.

Another index to the expansion and to the widespread interest in dairying and its extension on a more scientific basis is the increase in milk production per cow. From 1928 to 1938 in the Cotton Belt, which includes the three areas of most recent change, there was a general increase of approximately 325 pounds of milk per cow. This may be attributed to the improvement in the quality of the dairy cow, in the ration fed, and in the care and management of the cows. Vance holds that the increasing production per cow in many developing herds has demonstrated that climatic conditions do not prohibit high milk production in the South if other factors are regulated.

RELATIVE IMPORTANCE OF DAIRY FARMING

The milk production in proportion to the crop land (Figure 3) is considered by Hartshorne to be a good index to the importance of dairying in relation to other productive activities of farming. Measured both by the land use and by the value of the product sold, Harts-

horne concludes that for the United States dairying is the dominant feature of the farm system where the milk production exceeds 70 gallons per acre of crop land; that it is probably the most important of several significant branches of farming where the ratio is between 50 and 70; that dairying is less important than other phases of farm production, although there may be some surplus of dairy products sold on the farms, where the ratio is from 30 to 50; and that dairying is of minor importance where the ratio is below 30 gallons per acre.

Judged by this standard, the South has many small, widely scattered areas where dairying is the dominant activity. With few exceptions, the regions where dairying ranks highest in relative importance among the farm enterprises correspond to the centers of greatest density of dairy cows. It is noted that again the most significant sections are the Piedmont of Maryland and north Virginia, the mountainous areas, the Blue Grass region of Kentucky, central Tennessee, parts of east Texas, southeast Louisiana, east central Mississippi, and many small isolated areas that are evidently associated with city markets. Southwest Texas, on the other hand, stands rather low in the density of the dairy cows (Figure 1), but holds an outstanding position in terms of the relative importance of dairying (Figure 3). This is due to the low acreage in crops, as on the stony Edwards Plateau, where grasslands dominate. The areas near some of the larger cities of Florida, Tampa, Miami, and Jacksonville, also hold a higher rank in relative importance of dairying than is indicated by the map showing the density of the cows. Thus, from an examination of the maps and material presented, it is evident that there are certain sections in the South where dairying adds significantly to the farm income.

Early Development

It is apparent that commercial dairy farming in the South is, for the most part, of rather recent development. However, to appreciate more fully the significance of the present distribution and recent trends in this industry, an examination of past records is essential, for, in many areas, especially in the Lower South, the growth of this type of farm activity is intricately interwoven with and dependent upon the downfall of another type of agricultural economy. Only after repeated failures of the one-crop system did the dairy cow find a chance to compete with cotton. Consequently, the appearance of the boll weevil, which first made its entry into southern Texas in 1892 and spread over the entire Cotton Belt by 1922, is listed as a primary factor which led many areas eventually to dethrone King Cotton. The revolutionary effect of this insect is stressed by Smith and Phillips, who state that of the two shocks to the plantation system the one from the boll weevil was greater than the one from the War between the States.

Great was the havoc wrought by this pest in 1921 when it caused a reduction of one-third of the cotton crop, resulting in the smallest production since 1895. The boll weevil with its resultant, a significant agricultural revolution, gave the first great impetus to diversified farming.

However, as cotton failed, the dairy cow did not succeed immediately to make her imprint upon the affairs of the farm. Time was required for man to change his beliefs, ideas, and methods before one dominant activity could be subdued by some other. Sufficient knowledge and understanding to make

a transition from the well established type of farm production to that of the untried were lacking. This deficiency was recognized in 1909 by Rawl, who stated that dairying is undeveloped in the South largely because the farmers do not understand how to make it profitable.

Such, indeed, is the story of the development of dairying in sections of Mississippi, especially in the east central portion. In this State, the "heart of the Cotton Belt," the period immediately following 1909 was one of experiment and doubt. Cotton fell to the ravages of the boll weevil; dairying as

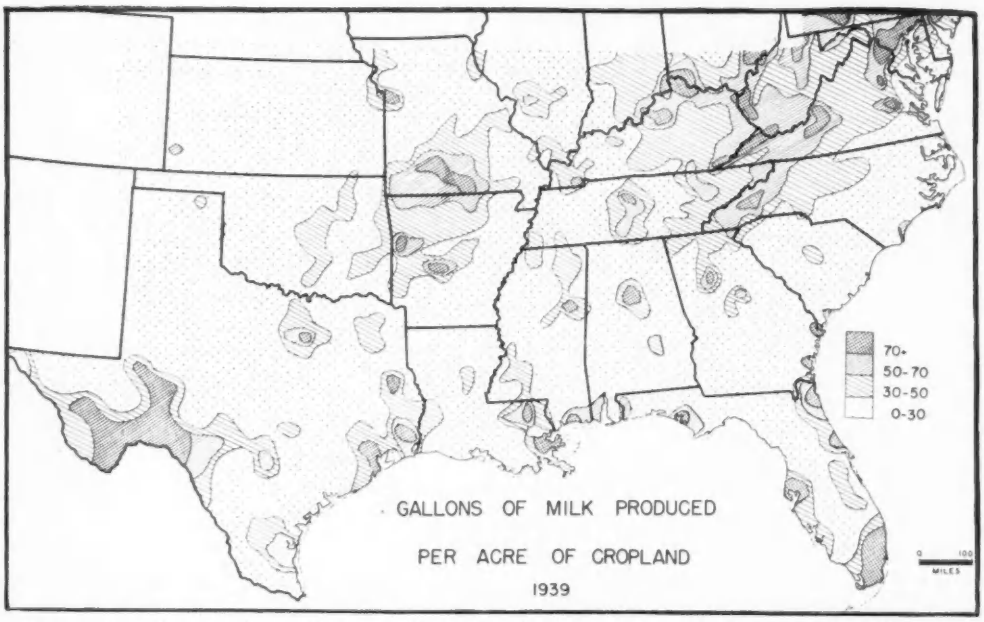

FIGURE 3.—The criterion, gallons of milk produced per acre of crop land, was used by Hartshorne as a satisfactory index to dairy farming. For noting recent changes, a comparison with his map (*Economic Geography*, 11, 1935, p. 349) is of value.

Moreover, financial difficulties often prevented the introduction of highly bred cows, the purchase of proper equipment, and the construction of suitable buildings. Furthermore, the Texas-fever tick was a definite barrier to dairying. The absence of large urban centers for markets, the limited extension of highways, the inadequacy of refrigeration, and the lack of suitable pastures were also important factors in retarding progress. Therefore, at first the development of dairying activities moved slowly and apparent successes were followed by failures that made the situation even more critical than before.

tried was not a success. So in Mississippi the year 1912 found this farm activity worse than nothing at all; it had been tried and had been pronounced a failure.

The decrease in cotton acreage for east central Mississippi took place more rapidly than that for the State as a whole. In this area the cotton lands of 457,000 acres in 1909 declined to 250,000 acres in 1919, or approximately 45 per cent in contrast to a decrease of 13 per cent for the State. This reduction, although primarily due to the boll weevil, was partially the result of the spread of Bermuda and Johnson grass over some of the most fertile land. With these factors limiting the cotton culture,

which is usually in direct opposition to dairying, and with the growth of resistant grasses to tempt farmers to use the land for pastures, parts of Mississippi made significant steps toward commercial dairying.

Since plants to serve as a market for milk were lacking, butter production was the basis upon which early development was founded. The amount of butter sold in Mississippi in 1909 was only 3,334 pounds in comparison to that of 1,864,596 pounds in 1919 and 8,147,166 pounds in 1927. Moreover, there was throughout Mississippi a real awakening to the value of dairying, as is indicated by the presence of twenty-four creameries in 1921, in striking contrast to their complete absence in 1912. According to Canfield, the erection of the $350,000 condensary in Starkville in the spring of 1926 marked the movement of mild plants into the South, and many states began to take on a "milky hue."

However, these revolutionary practices, which were encouraged by the boll weevil and the spread of resistant grasses, were made possible by the gradual eradication of the Texas-fever tick, a major handicap to early attempts in dairying. So critical was this problem, made more complex by the warm, moist climate with mild winters, that Congress planned a scientific program for the complete elimination of the tick. After the first appropriation of $82,500 on July 1, 1906, much progress was evident.

By 1913, in Mississippi, one of the badly infected states, operations for the destruction of this parasite were being carried on in 26 counties, and dipping vats were being constructed in 15 others. Nevertheless, these attempts to remove one of the major barriers to commercial dairying met serious obstacles, for the efforts did not coincide with the "folkways of the frontier." Dipping was often vigorously opposed by those interested only in raising a few scrub stock dependent on free range. But with concentrated effort those who regarded stock raising as a large scale industry, with the assistance of the Federal Government, and with the coöperation and supervision of the Federal inspectors and county agents, the South, with the exception of the extreme lower portion, was free from ticks by December 1, 1931.

Thus, with a major handicap removed; with the rise of industry and its accompanying resultant, the growth of urban centers providing increasing markets; with the widespread construction of highways; with more scientific knowledge concerning the care and management of the better bred dairy cows; and with the introduction of legume hay, milk production was placed more definitely on sound scientific basis. And in east central Mississippi dairying began to take an important place among the activities of the farm program. Additional factors which played significant roles in the agricultural revolution of this portion of the South were those of the natural environment. The fertile soil of this area, a great portion of which lies in the Black Belt of Alabama and Mississippi, and the relatively flat or gently rolling topography made the section well suited for the production of grasses and crops needed for dairying.

But regardless of noteworthy advances in dairy developments in this area, the interest in this type of farm economy and crop diversification somewhat lagged until, according to Kohn, renewed impetus was given by the economic depression and New Deal activities. The "collapse of the cotton market," resulting in extremely low prices for cotton in 1931, reemphasized the evils of the one-crop practice.

Consequently, in the decade from 1929 to 1939 the number of acres of cotton declined 49 per cent, while there was an increase of 44 per cent in the number of acres of arable pasture. This same period is characterized by a 97 per cent increase in acreage devoted to forage and hay. Thus, after alternating periods of expansion and decline, with many factors playing significant roles in its development, dairying in east central Mississippi is today a dominant feature of the farm system.

The rather revolutionary changes in farm practices in parts of Mississippi may be "regarded as typifying an almost unexpected southern trend in which Kentucky, Tennessee, and Texas have taken part."

Unlike east central Mississippi, however, east Texas did not turn to dairying until 1928, when it saw that its profits from cotton were being destroyed by root rot. Then attention was directed toward this more stable type of farm practice, and during a period of eighteen months following that date eight milk plants and nine cheese factories began operation. It is true that the roads were bad in many localities and markets were often remote, but the same factors that had led Texas to be the leading beef producing state assisted in its becoming a commercial producer of milk and milk plant products. The mild climate permitted low cost construction of dairy barns; the long growing season afforded practically year-round pastures and outdoor life which in turn resulted in a very low tuberculosis menace—.9 per cent for 1926 compared with 9.7 per cent for New York and 3.6 per cent for Wisconsin. So dairying developed rather rapidly, especially in the northeast near Dallas and Fort Worth.

In southwest Texas, on the other hand, the growth and development was more gradual, as there progress did not depend upon the failure of a well established crop, but upon improvements in transportation and extension of irrigation. Because of a deficiency in rainfall, portions of this area are principally grazing grounds best suited for livestock production.

In the states to the north of the Cotton Belt—the Upper South—the culture of corn and tobacco stood in opposition to the development of dairying, and early progress was retarded. Nevertheless, the growing season from 180 to 210 days provided a comparatively long period for grazing. Here, however, it was necessary to supplement, to a greater degree, the feed from the pastures with that provided by hay crops. The absence of cold winters, for the most part, and the presence of rich, productive soil, especially in the limestone basins of north central Kentucky and central Tennessee, made admirable possibilities for dairying. But for the Upper South in general, extensive developments were stimulated only after the appearance of the cream separator, improvements in refrigeration, the penetration of rural electrification into remote areas, the widespread improvement in the roads, and the organization of the Agricultural Adjustment Administration.

In the self-sufficing areas, on the other hand, the dairy products for home use and limited sale were of much earlier origin. A study by Doone and Reed in 1917 reveals that the first consideraton to the adaptability of dairying to the southern mountains was given in 1913 by the coöperative extension agent of North Carolina, and that cheese making in the home was an important industry in some of the mountain districts at the beginning of the twentieth century. Abundant rainfall, from 50 to 70 inches, and the lower tempera-

tures assisted in making these undertakings possible. Moreover, the very nature of the topography and drainage provided homes with springs which made facilities for cooling the milk. Although dairying had an early beginning in these deeply dissected areas of isolation, it remains even today primarily of the subsistence type, and the relative value of this enterprise is due largely to the lack of other products.

The development of dairying in the Piedmont of north Virginia and central Maryland was probably less associated with conditions of the natural environment than any other part of the South. For in this section population and location were dominant factors. This area was settled largely by Pennsylvania Germans. They were hard-working people who early began the intensive type of farming. Also, the location near the growing centers of population made markets available.

For most of the South, however, delayed technological developments, the implicit faith in the one-crop system, and difficulties presented by the Texas-fever tick, combined with other factors to delay the development of dairy farming. In many areas the very way of life itself was an obstacle to dairying, an industry which demands a well disciplined type of labor. The southerner, often too individualistic to yield willingly to the inelasticity of the demands of dairying, was content to continue with old types of soil mining procedures long after they had become a losing enterprise. Furthermore, the presence of the Negro and the high per cent of tenant farmers added to the complexity of the whole scheme of things. Consequently, marked developments in dairying were delayed until comparatively recent years.

IMPACT OF DAIRYING ON PEOPLE AND LAND

Considered on the basis of the returns both to the people and to the land, dairying holds a unique position in the South, for in this respect few are the farm enterprises that can equal it. Through dairying the farmer's attention is somewhat diverted from the cash crops, the "miners of soil and of men," to various channels that are far more profitable to him. With greater diversification of farming, dairying makes possible a steady cash income throughout the year.

Not only is the income steady and the work rather satisfactorily distributed during the year, but man is rewarded more profitably for his labor. The greater economic stability and the prosperity of the people are in turn reflected in a higher level of living, better housing conditions, and more desirable opportunities for personal development. Craddock Goins, in writing of the dairy prosperity in Mississippi and the Mid South, very impressively presents a picture of "farmers now depositing money in banks that they once dreaded to visit; farmers now trading at home and paying as they go, throwing away mail-order catalogues; farmers sending little children to school, instead of working them to death in cotton fields; farmers riding over paved highways in automobiles, instead of rattling along over rutty roads in wagons." Indeed, striking are the contrasts in the living conditions of the people before and after dairying became part of the farm program.

Closely associated with the standard of living of agrarian people is the degree to which the fertility of the soil is conserved or improved. This is a problem that has long confronted the agricultural leaders of the South, a land

of row crops, sloping fields, abundant rainfall, and alternate thawing and freezing in winter. Consequently, the conservation of the soil should be a prime objective of southern farmers. It is in this respect that dairy farming makes one of its greatest contributions, for it removes less fertility from the soil than does any type of farming which engages in plant production alone. It is estimated by Neasham that a ton of butter worth $1,000 takes only 70 cents worth of fertility from the soil, while the sale of feeds which would produce it would take $400 worth. This is, in part, made possible by the fact that dairying provides a market for home grown feeds, which when fed to the animals yield from 60 to 70 per cent of their original fertilizer value to the improvement of the land. According to Clarence Poe, there is a cycle of soil fertility which can be ignored only to the peril of the people:

"Soils feed plants;
Plants feed animals;
Animals feed soils."

Moreover, greater diversification of farming, which accompanies the development of dairying, tends to diminish the soil mining practices too long followed in the South. Also, areas that should be built up by improved grasses are often given a chance. That dairy activities and the production of hay crops go hand in hand is made evident by comparing the map (Figure 4) showing the per cent of the crops growing in hay with the map (Figure 3) indicating the relative value of dairying. It is found that the areas where hay holds a high position in relation to other crops correspond favorably to the sections where dairying is the dominant element in the farm program. Since hay crops aid greatly in reducing soil erosion, another effect of paramount importance is realized.

Thus in terms of the value received by the people and by the land, many are the advantages of dairying, as it makes for self-sustaining homes and a more permanent type of agriculture.

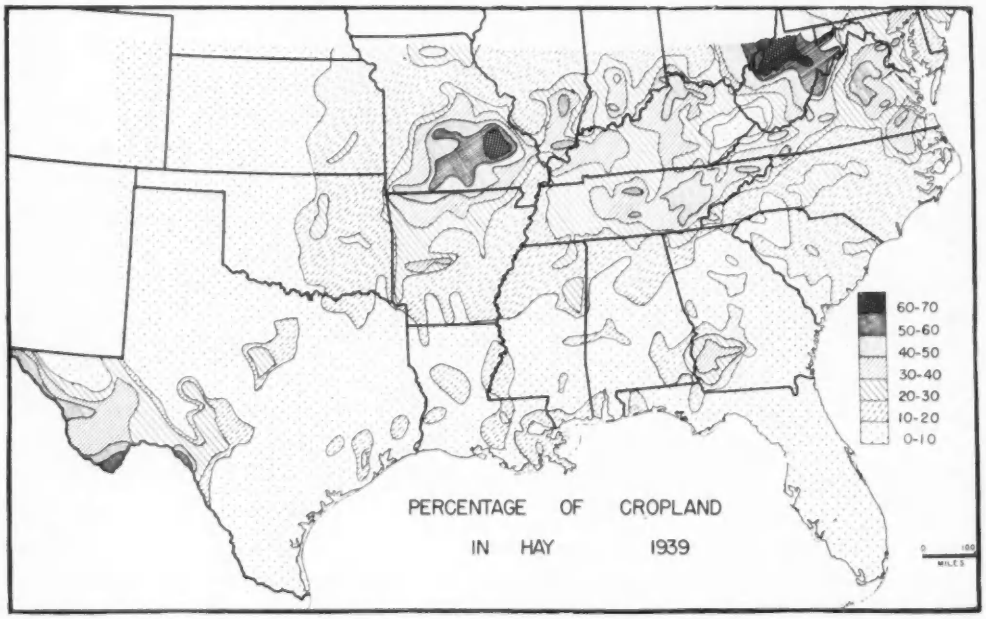

FIGURE 4.—Hay is not an important crop in the Lower South and in the western portion of the region, except in the irrigated districts.

PROSPECTS

Although the rise of the dairy industry in the South is, in part, a story of a "struggle against odds," this region has possibilities of becoming a greater producer of dairy products. Indeed, all the limiting factors cannot be minimized. The dry spells, which Parkins terms as the most widespread and destructive of all weather phenomena to agricultural operators in this region, continue at times to be very disastrous to pasture and forage crops. Also, contrasting periods of abundant rainfall make the production of hay a hazardous undertaking in parts of the Cotton Belt; and dependable labor, which is absolutely essential in the dairy business, is not always to be had. But the growing population centers create additional markets; the abundance of relatively cheap land provides ample area for pastures; the open winters permit rather inexpensive barn construction and outdoor life for the cattle; the long growing season affords grazing during the greater portion of the year; and the large variety of grasses and clovers of proved value makes possible improved pastures.

Yet the southerner can realize more fully the benefits of these advantages only by giving more careful attention to the quality and type of the pasture. It is held by Combs that the livestock industry in the South will be expanded only when the people recognize the potential value of good pastures, which are definitely essential for dairy production on an economical basis. Herein lies one of the South's great handicaps, the lack of improved pastures.

This deficiency does not mean that there is an absence of desirable grasses adapted to the soils and climate of the South, as was true in years past, but that the people in many areas fail to place the proper value upon grasslands. It is evident that some farmers today hold an indifferent or negative attitude toward grasses, partially because some of the indigenous varieties, especially the Bermuda and Johnson grass, are so aggressive as to be termed "poisonous" and unwelcomed on land that is later to be used for crops. However, for land that is to be used for permanent pasture, the superiority of Bermuda grass seems to be generally recognized.

But in contrast to these and other native grasses that are often a nuisance to crop lands are many introduced forage crops which provide good pastures or excellent hay plants. Significant are the many species of Lespedeza, known to make little preference for soil types; the various varieties of clovers, adapted to a wide range of climatic conditions; alfalfa, productive on the rich soils of the black prairies, on well-drained alluvial areas, and in semi-arid sections; Red Top, ranked second only to Kentucky blue grass in importance in the Upper South; timothy, productive on the moist, fertile clay or loam soil in areas north of the Cotton Belt; Sudan grass, the most widely cultivated hay plants in the Middle and Lower South; Rhodes grass, Para grass, and Carib grass, all adapted to conditions in the Lower South; and Natal grass, valued for its productivity on poor, sandy soils of the Gulf Coast. Although this list is by no means complete, it indicates that there is in the South today a variety of grasses and clovers of known value to make possible improved pastures.

Improvements in the pastures, the cheapest and most ideal feed, are accompanied by corresponding improvements in the dairy cattle. Therefore, the right conception as to the value of the pasture and how to make it better is a prime factor in determining future trends.

Further developments in dairying may also occur from an increase in the production of home grown feeds to supplement the pastures, an improvement in the ration fed, a use of more scientific methods, and a more thorough understanding and appreciation of the values of coöperatives.

Most assuredly, the writer does not wish to imply that every farmer should divert all his attention to dairying to the neglect of other well-tried procedures. This would lead to results as disastrous as the devastating soil depleting practices of the past. But many are the opportunities for a more satisfactory combination of the culture of crops in association with the further developments of dairying, an activity that should be considered not only a "business opportunity, but also an agricultural safeguard."

PATH OF THE SETTLEMENT AND DISTRIBUTION OF POPULATION OF MAINE

Charles B. Fobes

THE movement and distribution of the population of an area can be shown best by the use of maps. The following maps are an effort to more clearly represent the progress of the settlement and the present pattern of the population of the state of Maine.

In order to trace the gradual filling of the land, dates of the first permanent settlements have been noted for the civil divisions and these first occupied sections indicated on outline maps of Maine (Figure 1). The maps cover periods ending in 1700, 1760, 1780, 1800, 1820 and 1940. It should be held in mind that though certain areas are marked as settled, there were in most cases no concentrations of people but instead only a family or small group of families whose homes were situated in small clearings surrounded by the forests. Many times these homes represented the beginnings of communities that later developed. The pushing back or the exploitation of the forest went hand in hand with the settlement of Maine. The limits of settled portions of the state corresponded quite closely to the forest fringe.

The distribution pattern of the population in 1940 is shown on a map. The pattern is the result of economic, historic, and geographic factors that have played an important role in the development of Maine (Figure 2).

No attempt will be made to review in detail the history of the settlement of Maine, but it is well to note a few significant facts that affected the movement and final distribution of the inhabitants.

During the years from 1497 until 1623 when Richard Vines made the first permanent settlement in Maine, at the mouth of the Saco River, there was a period of Maine history that could be called the "Period of Exploration and Discovery." In that span of years many European adventurers explored the Maine and New England coast. There were no white people in Maine, but the Abenaki Indians were established in numerous villages along the Saco, Androscoggin, Kennebec, and Penobscot rivers.

With the offering of land grants and patents by the Great Council of New England in 1622 and later dates, coastal sections of southwestern Maine were soon occupied. Forests and Indians were a hindrance and settlers did not venture far inland. Between 1700 and 1760 Indian uprisings were widespread and frequent. Forts were built near the more important settlements in order to protect the new inhabitants. Lumbering was the chief industry. Under the direction of the "Crown," the mast trade flourished until the Revolutionary War. Albion states; ". . . the lumber industry became most important, forming the backbone of the economic existence and the chief motive for new settlements." Agriculture suffered; Parson Smith in 1737 wrote concerning Falmouth (Portland); "All the talk is,—no corn, no hay, and there is not a peck of potatoes to eat in all the eastern country."

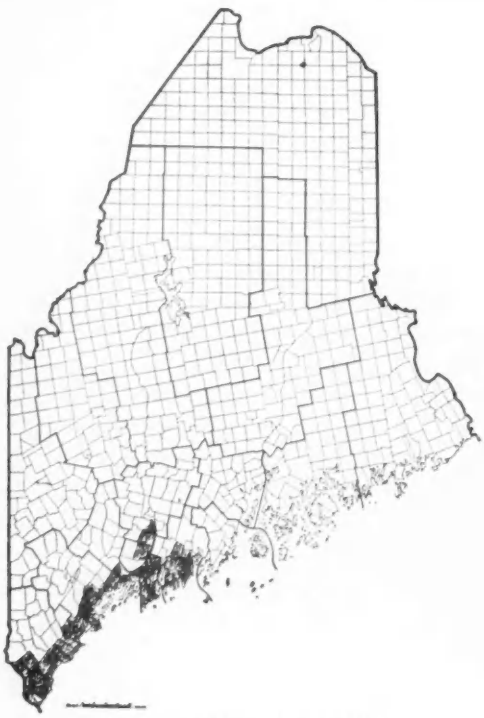

FIGURE 1.—Settled area, 1700.

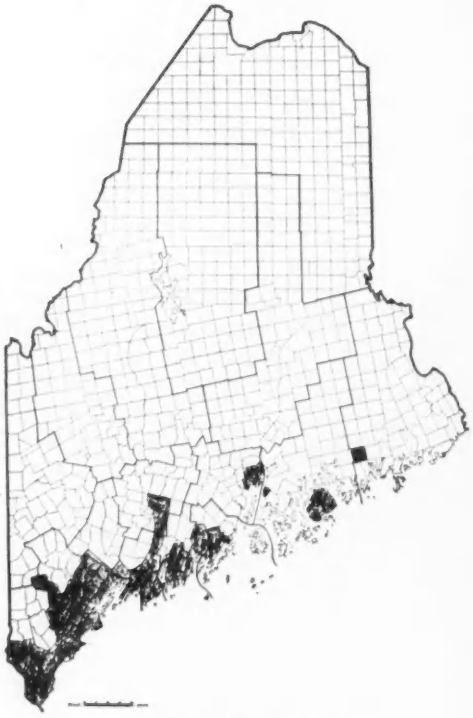

FIGURE 2.—Settled area, 1760.

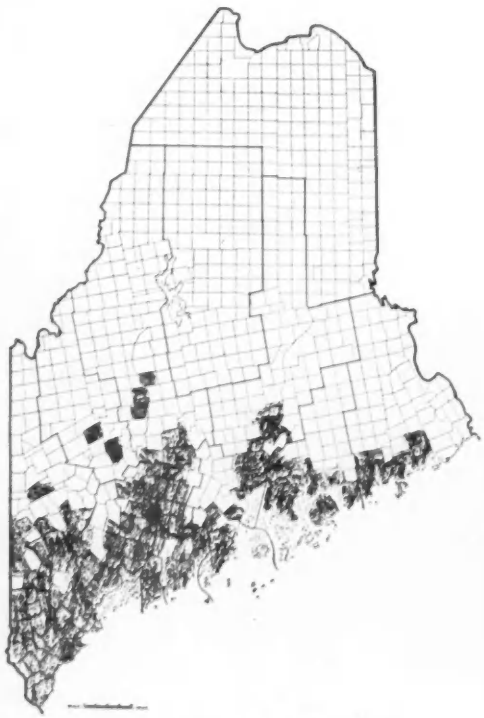

FIGURE 3.—Settled area, 1780.

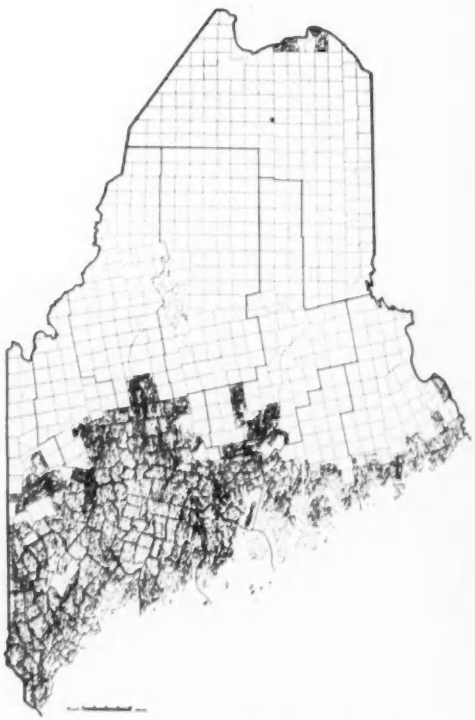

FIGURE 4.—Settled area, 1800.

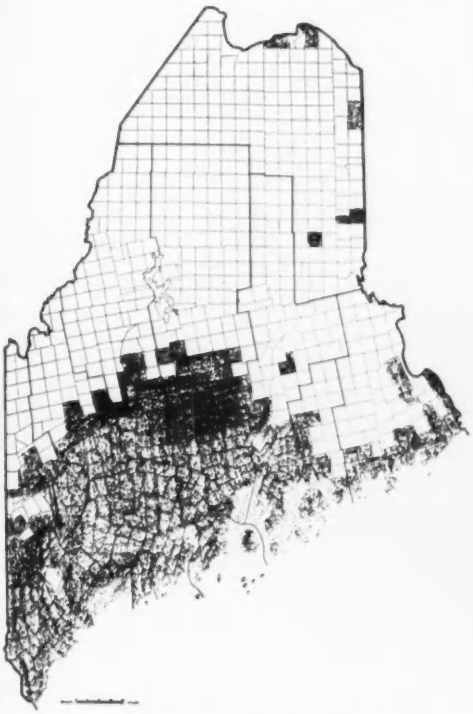

FIGURE 5.—Settled area, 1820.

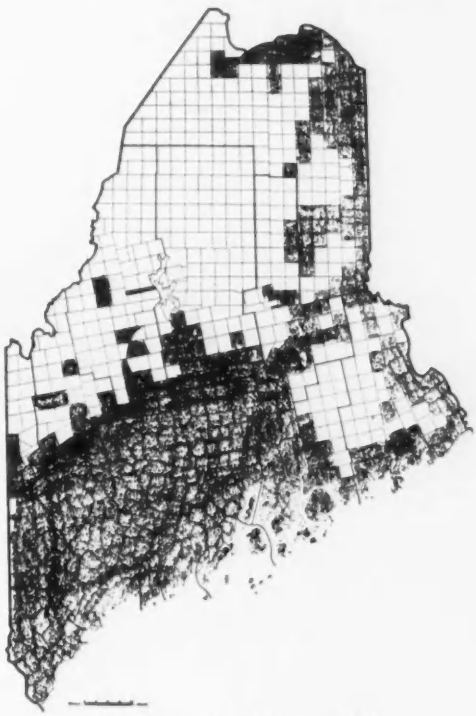

FIGURE 6.—Settled area, 1940.

Settlements progressed up the larger rivers, especially the Saco, Kennebec, and Penobscot after the final Peace Treaty with the Indians in 1760. By 1800 the areas between the rivers were fully occupied. It is of special interest to note the migration of Acadian refugees who entered Maine by the St. John river valley and founded northern Aroostook county. Transportation improved in southern Maine. Only rough roads existed and streams had to be forded; only the large rivers were crossed by bridges or ferries. Regular mail coach service between Portland and Boston was established in 1787 replacing the horseback carrier.

The War of 1812 temporarily halted the movement of people to new areas. With the cessation of the war, people returned to their favored occupations. Local industries began to find suitable sites near falls on the rivers that afforded power. In 1811, Brunswick, Wilton, and Gardiner supported cotton mills. One of the first woolen mills was erected at Lisbon in 1808. The population of Maine increased from 96,540 to 298,335 in the period from 1790 to 1820. Although the population increased, it has been estimated that nearly 15,000 persons emigrated to the west between 1816–1817. This exodus was called the "Ohio Fever" for many of the people found new homes in the state of Ohio. The "cold year" of 1816 probably was an inducive factor in this movement.

When Maine became a state in 1820, the whole southern section of the state extending from New Hampshire to the Penobscot river was fully settled. The coastal section between Penobscot Bay and Eastport was also populated. With the opening of the "Military Road" in 1834 from Bangor to Houlton, the settle-

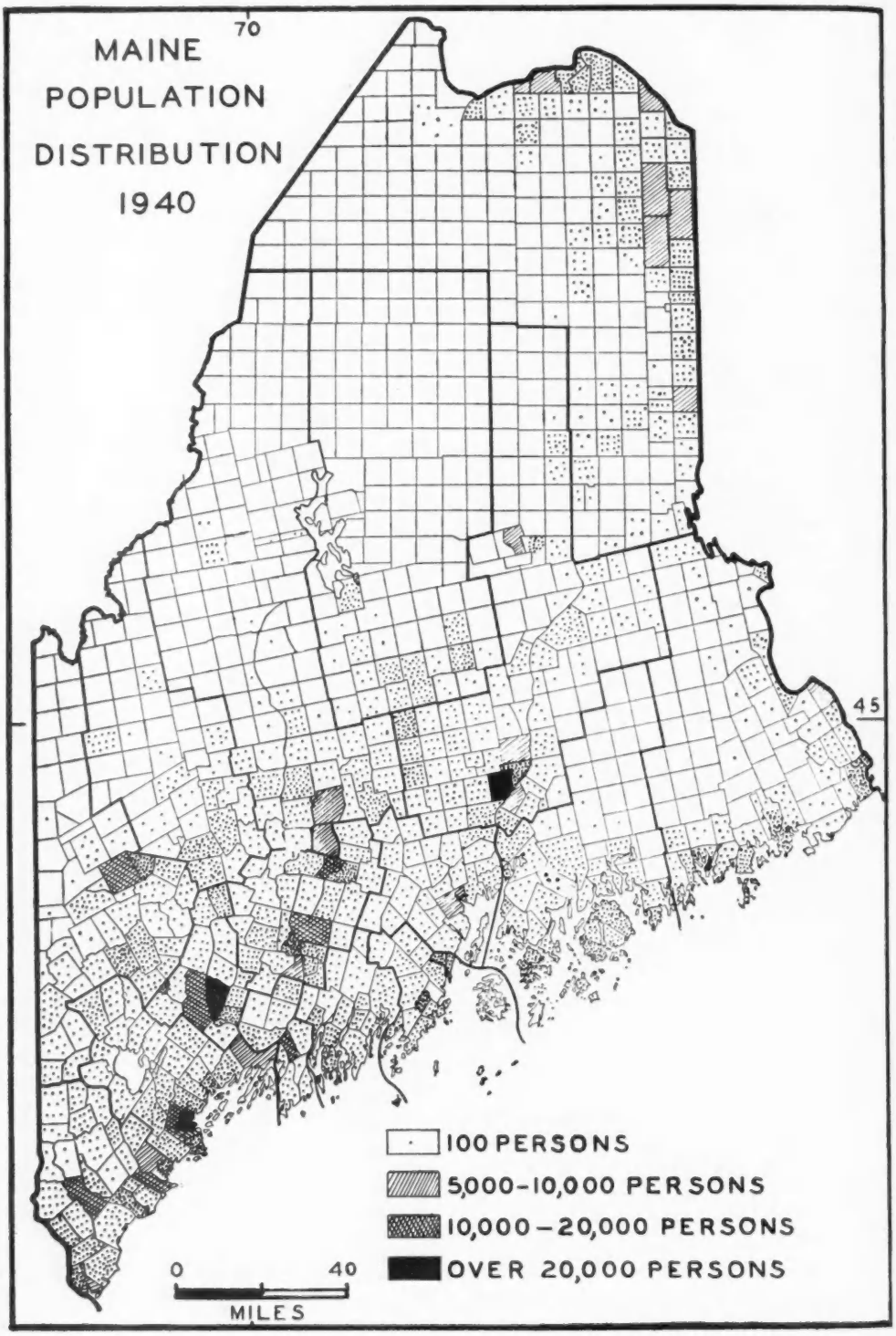

FIGURE 7.—Population Distribution, 1940.

ment of the southern half of Aroostook county started. The great demand for export lumber at the port of Bangor hastened the removal of the forests in the newly opened territory. In 1870 Aroostook county had a population of 29,609. The final settlement in Maine was made in the same year when the town of New Sweden was established.

The influence of the coast, rivers, and favorable soil and climatic conditions are reflected by the concentrations of people in various places throughout the state. The distribution of the population is shown on an accompanying map.

The rivers by offering ample water power, have been the chief reasons for the location of the cotton, woolen, and paper and pulp industries along their courses. These basic industries with their service trades have resulted in the growth of many large communities, namely: Sanford, Biddeford, Saco, Westbrook, Brunswick, Lewiston, Auburn, Waterville, Fairfield, Augusta, Gardiner, Skowhegan, Madison, Oldtown, Orono, Rumford, and Millinocket. These towns support a population of 207,591.

Such communities as Portland, South Portland, Bath, Thomaston, Rockland, Belfast, Bangor, Eastport, Lubec, and Calais are centers of fishing, shipbuilding, and water borne transportation. In many cases the coastal towns have enjoyed greater prosperity in the past and maintained a larger population than at present. These ten communities have a population of 158,068.

The Aroostook county area is probably the most successful potato raising county in the world. The main reasons for the importance of this agricultural region are the hazel-brown silty loam soil, underlain with a calcareous shale which is ideal for growing potatoes. The climate is favorable for potatoes and the topography is essentially a rolling plain that is well adapted to large scale farming. The principal towns in this area are Presque Isle, Houlton, Caribou, and Fort Fairfield; they have total population of 29,535.

These maps show that the settlement of Maine started in the southwestern section of the state and gradually extended along the coast to the Kennebec river. From the coastal area, the next movement was up the navigable rivers and also inland. The general movement was in a north and northeasterly direction. However, the migration of the Acadian refugees was south from the northern tip of the state. The settlement of new areas was at first slow but with the cessation of Indian hostilities and increase of trade with England, the movement progressed inland at a more rapid rate. By 1820 the whole southern part of the state was fully occupied. With the development of industry, increase of commerce, and the specialization of agriculture at favorable sites, the population became concentrated at different localities. As a result Maine in 1940 supported a population that was 40.5 per cent urban and 59.9 per cent rural.

COTTON IN THE ECONOMY OF MEXICO

Lorene A. Garloch

LATIN America produces 21.51 per cent of the cotton grown in the Western Hemisphere. Mexico, that land to the south of us so closely associated with corn and oil but so seldom with cotton raises 9.57 per cent of the total Latin American production. Cotton is the most important commercial crop in Mexico and it is the second crop in money value, being surpassed only by corn.

Cotton has been cultivated in Mexico from time immemorial. Prior to the advent of the Aztecs into the Valley of Mexico, their predecessors knew and practiced the art of cotton spinning. The discovery of cotton fabrics in tombs and temples of earlier races indicates that cotton was known and used by these peoples. It seems probable that in Mexico, as in Asia, cotton clothes were worn at a time when they were unknown in Europe. Cotton is believed to be native to Mexico, for it was found growing wild in many parts of the country, and early Spanish settlers found Indians growing and using cotton. In 1519, when Cortez invaded, he found the cotton fabrics of the Aztecs to be of such a degree of excellence that he sent some of their handiwork to the King of Spain. The Aztec women had two hundred methods of manufacturing cotton.

Cotton was first cultivated in Mexico on the Gulf Coastal Plain in the state of Vera Cruz. Later its cultivation was extended to the Pacific Region into the states of Oaxaca, Guerro, Jalisco, and Colima. These regions were the only producers until the middle of the nineteenth century. In 1840, cultivation began in the Conches, and in Laguna between 1840 and 1860. The other regions were much later in developing; Matamoros in 1892, Mexicali in 1901, although the Region did not attain importance until 1928, Juarez in 1922, Don Martin in 1925, and the Yaqui in 1928. Until 1916, the cotton produced supplied only the factories of the cotton producing regions. With the increase in the Laguna production, cotton was shipped to factories all over Mexico (Table I).

In modern times, cotton was cultivated from 1860 on, but up until 1892 it was Mexican cotton. The native cotton plant had a life of about eight years, the first two of which gave a small yield, the third, fourth, and fifth years were good years but in the later years, production declined. The acreage was then estimated at from 12,500 to 50,000 acres, and production was about 50 bales per lote. The native plant flowered late and picking did not start until September so that the crop was frequently ruined by frost. Not until American seed, with its early fruitage and large yield was introduced about 1892 did the crop become profitable.

The manufacture of cotton in Mexico dates back to about 1835. Among the earliest mills still operating are those of Cocolapan, founded in 1840, and of Vista Hermosa, founded in 1844. The industry increased slowly until 1894. During the nineties, the mills made big profits but confined themselves entirely to coarse goods. By 1899, the market had become so over-

stocked and competition was so keen that a large number of mills were forced to close. Since then a few of the larger and better managed mills have manufactured goods of medium grade, and these, as a rule, have made money but those confining themselves to the lower grade goods have had their ups and downs.

The chief centers of the cotton textile industry of Mexico are in the state of Puebla, with 63 mills employing 12,725 workers, the Federal District with 47 mills employing 6,129 workers, and Vera Cruz with 10 mills employing 7,041 workers. The remaining mills are scattered over 15 states (Table I). The textile industry is the most important industry of Mexico but the market for cotton goods is sharply divided. The larger market is for cheap cotton goods, principally "manta," a coarse grey sheeting, which is supplied almost entirely by the domestic mills. The other market covers the better grade of goods which do not compete with those locally made.

The cotton mill consumption in Mexico increased from 250,000 running bales in 1940–41 to 330,000 in 1941–42, and a level of 400,000 was predicted for 1942–43. Many mills now operate two shifts per day. Stimulated by increased demands from Central and South America as well as from the Caribbean Islands, the mills have mounted steadily in their output as well as in number. There were 185 factories in 1935 and over 220 in 1942, 830,000 cotton spindles were in operation in 1943.

The increased consumption is paralleled by a drop in exports of unmanufactured cotton. The exports in 1929 were 16,081 metric tons; in 1938, 20,781; in 1940, 5,238; in 1941, 12,871; in 1942, there had been no exports during the first eight months. This decline in exports appears to have resulted from relatively high domestic

TABLE I

MOVEMENT OF COTTON BETWEEN THE PRODUCING REGIONS AND THE STATES OF MEXICO WHICH UTILIZE IT, 1934–35

Utilizing States	*Producing Regions*								
	Laguna	*Mexicali*	*Yaqui*	*Jaurez and Conchos*	*Metamoros*	*Don Martin*	*Other Regions*	*Imports*	*Total*
	KILOS								
Coahuila	1,531,364	.....	.....	.....	1,095,381	22,969	159,914	.....	2,809,628
Chihuahua	152,193	.....	.....	594,275	.....	.....	.....	.....	746,468
D. F.	3,674,184	.....	.....	285,961	746,300	201,873	141,347	.....	5,049,665
Durango	56,533	.....	.....	.....	.....	.....	16,297	.....	72,830
Guanajuato	1,650,027	.....	.....	.....	95,000	74,101	.....	52,274	1,871,402
Hidalgo	272,148	.....	.....	.....	96,710	126,304	.....	.....	495,162
Jalisco	2,749,014	.....	.....	.....	.....	.....	.....	.....	2,749,014
Mexico	2,666,634	.....	.....	.....	46,682	.....	87,108	.....	2,800,424
Michoacan	68,745	.....	.....	.....	166,795	.....	42,171	.....	277,711
Neuve Leon	409,314	.....	.....	.....	335,723	182,091	.....	.....	927,128
Nayarit	.....	.....	.....	.....	.....	.....	487,613	.....	487,613
Oaxaca	182,031	.....	.....	.....	.....	.....	.....	.....	182,031
Puebla	12,808,120	.....	.....	.....	768,184	703,113	127,872	.....	14,407,289
Querétaro	1,425,119	23,234	.....	.....	349,064	.....	23,629	.....	1,821,051
Sinaloa	.....	.....	.....	.....	.....	.....	148,090	.....	148,090
Sonora	.....	146,400	151,324	.....	.....	.....	99,829	.....	397,553
Tlaxcala	1,396,078	.....	.....	135,207	599,254	.....	100,478	.....	2,231,017
Vera Cruz	4,547,746	67,830	.....	573,630	1,668,595	21,474	292,554	72,917	7,244,746

Romero, J. L. *Analisis de la Situacion Algodonera de Mexico*, Mexico (1938).

prices and to an increase in consumption by local mills. Considerable surplus cotton had previously been produced for export each year. The bulk of the raw cotton had been exported to Japan, the United States and to Germany with a much smaller amount being shipped to England (Table V). The cotton sent to the United States was re-exported.

In Mexico, there are now six important cotton regions, namely Laguna, Mexicali, Matamoros, Juarez, Conchos, and Don Martin. These regions account for 92 per cent of the cotton produced in Mexico while the remaining eight per cent is scattered throughout three other areas—the Valley of the Yaqui, the Gulf Coastal Region, and the Pacific Coastal Region. During the four year period, 1930–31—1933–34, the Laguna Region produced 60 per cent, Mexicali 16 per cent, Matamoros 10 per cent, Juarez five per cent, the rest came from widely scattered sections (Table II).

The commercial cotton is of the Upland type with a better staple in the Mexicali Region and a medium to short in all other districts. The average yield per hectare of cotton in Mexico is over one and one-half times that of the United States. Despite this, Mexican cotton has attracted little attention in the world market. The total crop in recent years has averaged 300,000 bales. In the quality of fiber, as well as in the general appearance and the size of bale, the Mexican crop resembles the cotton grown in the United States. Practically all Mexican cotton is about one inch staple and of a good degree of fineness and color. A lack of uniformity in grading has been its worse fault. This similarity of quality and appearance, plus the ability of the trade to sell the cotton in world markets on an equal with that grown in the United States, makes the question of further expansion of Mexican production of especial interest to American cotton growers. The amount of cotton produced in Mexico is increasing from year to year (Table III). A record 1942 cotton crop of at least 435,000 bales of 478 pounds each was forecast for Mexico compared with 371,000 bales in 1941. Water for irrigation was sufficient, insect damage was slight, weather conditions were generally favorable, and the quality of the fiber was forecast to be better than usual.

The system of growing cotton in Mexico cannot be compared with that of our great cotton belt but rather with the type of cotton production found in

TABLE II

PRODUCTION OF MEXICAN COTTON BY REGIONS, 1930–31—1938–39

Year	*Region*						
	Laguna	*Mexicali*	*Don Martin*	*Matamoros*	*Juarez*	*Conchos*	*All Other Regions*
	BALES						
1930–31	63,600	45,000	*Not available*	15,788	10,513	902	23,472
1931–32	147,962	26,000	*Not available*	13,776	10,084	442	10,470
1932–33	59,869	14,000	2,356	10,631	6,961	152	6,897
1933–34	176,539	18,000	8,634	33,726	12,831	939	9,403
1934–35	111,744	22,000	18,587	40,817	10,700	9,685	12,629
1935–36	116,145	72,000	26,168	15,497	726	11,807	29,369
1936–37	166,633	61,000	41,216	31,132	16,602	23,917	39,989
1937–38	127,574	52,000	32,093	46,582	23,800	31,088	25,662
1938–39	101,000	34,000	3,000	55,000	17,000	26,000	21,000

Norris, P. K., *Cotton production in Mexico*, Washington, Government printing office (1940).

TABLE III

AREA, PRODUCTION AND YIELD PER ACRE OF COTTON IN MEXICO

Year	*Area Acres*	*Production Bales*	*Yield per Acre Pounds*
AVERAGE			
1909–10 to 1913–14	253,000	187,000	358
1924–25 to 1928–29	443,000	243,000	261
ANNUAL			
1929–30	491,600	246,000	239
1930–31	390,300	177,500	217
1931–32	319,000	210,200	315
1932–33	192,400	101,500	252
1933–34	424,300	260,400	293
1934–35	417,900	223,000	255
1935–36	598,700	250,500	200
1936–37	844,000	395,300	224
1937–38	829,300	340,000	196
1938–39 (Preliminary)	633,400	305,600	231

Norris, P. K. *Cotton production in Mexico*, Washington, Government printing office, 1940.

the valleys of the Indus, Nile, and Salt rivers for these sections depend upon irrigation for their crops. All of the great cotton regions are on alluvial deposits but short staple cotton is grown in contrast to the long staple of similar regions in India, Egypt, and California. This is due to climatic features rather than to a difference in the soil.

Mexico has all of the cotton insects common to North America, the two most destructive being the pink bollworm and the boll weevil. Both are well established in the chief cotton-growing areas of the Republic. Insect losses are sometimes as high as 50 per cent of the crop. The pink bollworm, which is the most destructive, is said to be responsible for losses ranging from 10 to 70 per cent of the crop. From 1920–25, the pink bollworm destroyed the larger portion of the Laguna crop. Studies of cultural control indicate that a comparatively high mortality can be brought about by winter control measures, especially by burying or steam heating the gin trash. However, the most interesting results have been attained by grinding this trash in a mill designed for the purpose. Such an experimental mill, set up in Laguna, proved 100 per cent efficient. The boll weevil is also destructive, and during certain seasons it reduces the yield tremendously. At present, the cotton production in most regions is holding its own against the ravages of insects, but should insect damage increase, it will cause many farmers to shift from cotton to other crops for damages by insects place a severe handicap upon cotton production in Mexico.

Other cotton plagues in some of the regions are the cotton bollworm, the cotton leaf worm, cotton withering, root rot, and root withering. Two types of grass have also been added to the list of plagues. Johnson grass has been so plentiful in late years in the Laguna Region that many fields have been planted to wheat rather than to cotton. Grama grass is so prolific that no cultivation is possible on the land covered with it.

The Mexicali Region has a large cotton acreage of 60,000 acres. If sufficient water were available, 400,000 acres

TABLE IV

AREA, PRODUCTION AND YIELD PER ACRE OF COTTON IN THE LAGUNA REGION

Year	*Area Acres*	*Production Bales*	*Yield per Acre Pounds*
1929–30	205,200	112,000	261
1930–31	190,000	63,600	160
1931–32	169,937	147,962	416
1932–33	106,824	59,869	268
1933–34	194,732	176,530	433
1934–35	150,302	111,744	355
1935–36	164,176	116,145	338
1936–37	345,628	166,633	230
1937–38	224,632	127,574	272
1938–39 (Preliminary)	156,892	101,000	308

Norris, P. K. *Cotton production in Mexico*, Washington, Government printing office, 1940.

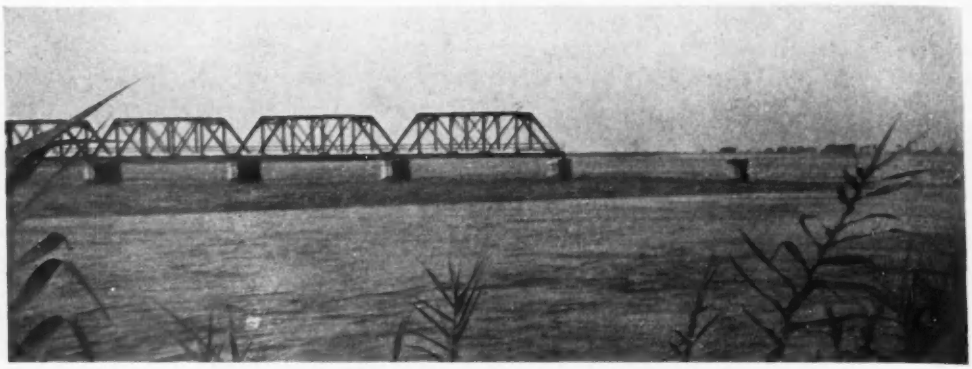

FIGURE 1.—The Nazas River at the height of the flood period.

could be cultivated. However, the Region, located on a part of the delta of the Colorado in Baja California displays decided disadvantages due to the location in regard to the rest of Mexico. All cotton sent to the interior regions must pass through the United States via Arizona or California. This is favorable for export to the United States or to Japan but not for internal use. The planting of cotton on the same land each year has resulted in the loss of soil fertility. Large areas have been abandoned because of the low yield resulting from constant cultivation or because of the salting of the irrigation water. The area is also heavily infested with Bermuda grass and other obnoxious vegetation.

The Matamoros Region is located in the flood plain of the Rio Grande extending for approximately 125 miles and covering 37,000 acres. The average rainfall is 30 inches so little irrigation is needed.

The Juarez Region covers 20,000 acres. The Region extends about 30 miles along the flood plain of the Rio Grande from Ciudad Juarez to San Ignacia. Due to the scarcity of pests, the best quality cotton in Mexico is produced here.

The Conchos Region extends for 300 miles along the Conchos River in the state of Chihuahua to the Rio Grande. Only 17,000 acres are in cotton.

The Don Martin Region has a much greater acreage than the others, 90,000 acres. Both the soil and the water are high in soluble minerals and only the most skillful handling will assure continuance of the cotton cultivation in this Region.

Several scattered districts of Mexico produce small quantities of cotton, the total of which may exceed 40,000 bales annually. Chief among these is the Yaqui Region situated in the valley of the Yaqui whose waters irrigate and fertilize the ground. The Region includes the municipalities of Ciudad Obregón, Bácum, and Cócorit. This Region is increasing in importance. The Pacific Coastal Region produces some cotton but must depend principally on local markets. It includes the states of Sonora, other than the Yaqui section, Sinaloa, Nayarit, Jalisco, Guerro, Oaxaca, Chiapas, and Colima. The products of the Gulf Coastal Region are consumed locally since it is close to the great textile city of Orizaba. These three areas are, however, relatively unimportant and promise little expansion in the future.

In contrast to these regions, the Laguna Region has had over 200,000

acres in cotton and, with the completion of the Palmito Dam, can have much more. The soil is excellent alluvium with no need for artificial fertilizer. The Region has a central location for both export and internal use. The amount of land which could be put under cultivation far surpasses that of the other regions. The basin is flat and machinery can be used advantageously. This flatness is also an aid in water distribution. The Laguna Region has promise of continuing as the greatest cotton region of Mexico as the before-mentioned advantages have made it more successful than any of the other regions.

More cotton is grown in the Laguna Region per acre than in any other place in the world. Tables III and IV permit a comparison between the yield in Laguna and that in Mexico as a whole. The cotton raised in this Region is considered to be the best in the country. The numerous varieties which are cultivated here cause the fiber to be variable, measuring from seven-eighths inches up to one and one-eighth inches. This variability of length permits the cotton from Laguna to be used in factories making all types of articles. Because of its white and shiny color, it is preferred by blanket factories and because of its silky texture, it is preferred by manufacturers of fine goods.

In 1884, varieties imported from Louisiana, Georgia, and the Carolinas were sown in Laguna. Finally ENCINO, from Texas, was grown with excellent results. It was very prolific, its color was a glossy snowy white and its length of staple measured from seven-eighths to fifteen-sixteenths inches, sometimes even to one inch. As industrialists have demanded longer fiber, this type has commenced to lose ground.

The Secretary of Agriculture now recommends the variety *Maravilla Del Sur* due to the uniformity of its fiber. It is the most popular variety in Laguna. The plant is small and very prolific. Three hundred tons of seed of this variety are imported each year. The seed of Laguna is not disinfected and the Agricultural Sanitary Authorities oppose its use with just reason. However, the farmers, without authority, sow the seed the second and third years saying that it is better acclimated and therefore yields more. Two other varieties, *Sure-Crop* a descendant of *Acala*, and *La Securiti* are also grown in this Region. *Sure-Crop* is very easy to pick and to gin. It produces a white silky fiber of one and one thirty-second inches. *La Securiti* has given excellent results in Laguna with its long fiber measuring from one and one-sixteenth to one and one-eighteenth inches and its snowy white silky texture.

The staple in Laguna is shorter and weaker than that in the United States due to the extreme dryness of the climate and to the entire absence of night dews during August and September when the cotton is ready for picking. A few years ago, an effort was made to

TABLE V

EXPORTS OF RAW COTTON FROM MEXICO TO PRINCIPAL MARKETS, 1929–1938

Country	*Bales of 478 Pounds Net*				
	1929	*1933*	*1936*	*1937*	*1938*
United States	61,856	1,448	83,509	2,352	39,321
Italy	.....	.....	5,073	2,532	17,810
Germany	2,966	3,729	57,152	14,702	15,306
United Kingdom	3,939	.....	10,828	4,522	12,685
France	4,754	422	.....	.....	6,375
Poland	.....	.....	.....	.....	407
Japan	.....	.....	60,518	15,088	.....
All others	652	477	12,672	2,270	5,404
Total	74,167	6,076	229,752	41,466	97,308

U. S. Tariff Commission. *Foreign Trade of Latin America, Part III*, Washington, Government printing office, 1942.

introduce Egyptian varieties, but experiments showed that this type of cotton was not profitable under existing conditions and production was abandoned. All cotton now grown is American Upland. This Region produces 95 per cent of the Upland cotton of Mexico. The following chart illustrates the grades of cotton produced in Laguna.

TONS

Grades	*1936–37*	*1937–38*	*1938–39*[1]
Good Middling	6,331	7,886	4,500
Strict Middling	21,360	18,402	18,576
Middling	8,083	6,786	6,965
Strict Low Middling	5,472	2,688	3,955
Low Middling	1,222	1,303	896
Other classes	298	308	357

[1]Rulfo, J. M. *El Futuro del Algodon Mexicano*, p. 102, Mexico (1941)

The following recommendations should be considered if the cotton production in Mexico is to expand. (a) Experiments to obtain profitable production of long staple cotton should be carried on in the various regions, comparable to the experiments which are being carried out in the United States. (b) Special emphasis should be placed on eradicating pests. (c) The cotton textile industry should be improved by reducing the cost of production and by increasing the manufacture of cheap goods of good quality. (d) Ample protection should be given to the cotton textile industry and extensive experiments should be made in order to use the fiber in making a greater variety of goods than those which are manufactured at the present time. (e) Mexico should carry on negotiations with the United States so that its quota could be increased to at least 26,000 tons. Upon the whole, Mexico may be expected to continue to produce sufficient cotton to supply the requirements of the local textile industries, but the possibility of production to a point at which exports will play an important part in the world's cotton market is rather remote at the present time.

The larger per cent of the cotton produced in Mexico is of a short and semi-long fiber. It suffices to cover her industrial necessities, producing annually an excess which must be exported. Mexico exported each year about 97,000 bales of which almost 50 per cent was sold to the United States and the other 50 per cent to different European and Asiatic countries (Table V). Actually, Mexico has now lost all European and Asiatic markets because of the war.

The cost of cotton production and textile manufacture are higher in Mexico than in other producing countries, so that, in competition, Mexico is placed at a distinct disadvantage. However, production for domestic consumption is encouraged by a growing textile indus-

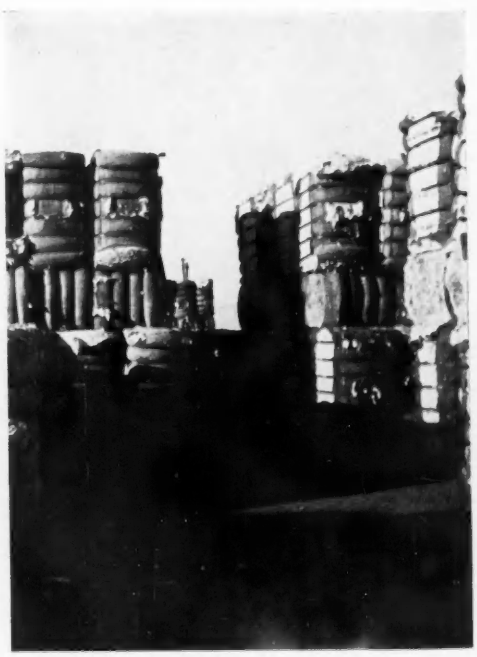

FIGURE 2.—Bales of stocked cotton.

try and by the high prices of cotton on the local market. Further expansion of the cotton acreage of Mexico would involve large outlays of capital for irrigation works, farm implements, and ginning machinery unless the present trend were reversed and land in food diverted to cotton.

BOOK REVIEWS

BENGTSON, NELS A., AND VAN ROYEN. *Fundamentals of Economic Geography.* Prentice-Hall, Inc., 1942, New York. Price $5.00.

TREWARTHA, GLENN T. *An Introduction to Weather and Climate.* McGraw-Hill Book Company, Inc., 1943. Price $4.00.

CARLSON, FRED A. *Geography of Latin America.* Prentice-Hall, Inc., New York, 1943.

The three following brief reviews are of books which have undergone recent revision. Both books are of primary importance to the geographer. They have been brought down to date, improved in subject matter and format, and substantially revised to greater or lesser degree. They are books that have stood the test of time and of applied use as text in many institutions. That they have been revised thoroughly and reprinted, proves that they have satisfied the demands of the fields for which they were originally conceived and published.

"An Introduction to Weather and Climate" has become so well known that no comment upon its high quality, its excellent organization, or its sound science is necessary. Everyone who has had occasion or opportunity to use the book in its first edition, which appeared six years ago, will be eager to have this newer edition, with all its improvements, additions, and up-to-date explanations. Part I, dealing with the elements of weather and climate, has been rewritten to expand and deepen the general content, with the result that it has been lifted to a higher and more advanced level. An entirely new chapter has been added, that deals with the origin and development of air masses, atmospheric fronts and the continental distribution of air masses. Köppen's climatic classification is used in modified form, climatic boundaries are statically defined, and a new map of world climates has been included. The volume has been more richly and more usefully illustrated. Many other changes have been introduced to make the book more valuable, both as textbook and as reference. It has not lost a single thing by revision and has gained a great deal. It remains, without question, the leader in its field.

"Geography of Latin America" has likewise been thoroughly revised. The increasing enthusiasm for the Latin Americas and the good neighbor policy adopted as the keystone of our national relations with the Latin-American Republics have provided a much broader and deeper basis for an understanding of the American lands and peoples to the south of our country. The author has retained as the core of his revision the political unit, discussing each country in its entirety in the orthodox geographic way, beginning with its natural setting and ending with its international relations. Two continental chapters that deal with the cultural development of Latin America, and the political pattern of its governments, and three chapters on intercontinental aspects—transportation, commercial relations, and summary—have been added to the original addition. Population data have been revised and several maps in color have been added. The revised edition will doubtless appeal to a larger audience than the first edition did.

For more than seven years Bengtson and Van Royen's "Fundamentals of Economic Geography" has served the college field well and acceptably. It has been used in an ever expanding number of colleges and universities and has become perhaps the most popular book in the field. The necessity for a new edition with the eighth printing became so imperative that it could not be delayed and now this revised issue appears to popularize the book still further and to modernize it in every respect. Particularly have the vicissitudes of the present war been recognized in their geographical significance, but as the authors point out "From the viewpoint of general economic geography it may rightly be said that 'there will always be a Norway, a Holland, a Belgium, a Poland, or a Czecho-Slovakia,' regardless of how some details of names or political boundaries may be changed. A correct appreciation of major and *lasting* changes brought about by the Second World War in the development of resources and in the quantities and types of goods produced in various parts of the world must wait until some time has elapsed after the close of the conflict."

All three of these books are sure not only to retain their popularity in the teaching field, but to increase it. They have demonstrated their utility and their value. In the reconstruction period following the war, geography is likely to become of greater significance than ever before, and such books as these will serve more advantageously in the future than they have in the past.

W. E. E.